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Draft
Biological Evaluation

McCormick & Baxter Creosoting Company
Portland Plant
6900 North Edgewater Street
Portland, Oregon

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Prepared for:

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Project Summary

Ecology and Environment, Inc., under contract to the Oregon Department of Environmental Quality (DEQ), has prepared this biological evaluation (BE) to meet substantive and procedural requirements of the Endangered Species Act of 1973, as amended (50 Code of Federal Regulation [CFR] 17.11 and 17.12). The federal action agency for this project is the United States Environmental Protection Agency (EPA) with DEQ functioning as the lead agency.

The project site, McCormick & Baxter Creosoting Company at 6900 North Edgewater Street is a former wood-treating facility located along the Willamette River (see Figure 1). The property, approximately 43 acres, was a highly developed industrial area with little terrestrial wildlife habitat. As a result of past practices, the site is heavily contaminated with wood-treating chemicals. The site also includes approximately 15 acres of contaminated Willamette River sediment and shoreline (see Appendix A Photographs 1 to 4).

On June 1, 1994, EPA added the site to the National Priority List (NPL). In March 1996, the record of decision identified EPA and DEQ's selected final remedial action (RA) for the project site. The remedy was developed in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, (42 United States Code §9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR 300 to the extent practicable. The development of the final RA required input from several federal and state agencies, including the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). Previous agency correspondence is presented in Appendix B. The selected remedy includes capping shoreline sediment that exceeds human health and ecological risk-based criteria or that exhibits significant biological toxicity.

Future reuse of the site could include industrial or recreational scenarios with in-place institutional controls (e.g. deed restrictions). Notifications regarding areas where dredging restriction should be instituted will be given to the United States Army Corps of Engineers (USACE) and Oregon Division of State Lands. Measures to restrict or prohibit dredging will be pursued with USACE (the agency responsible for issuing dredging permits) and the property owner(s), to ensure long-term protection of the cap.

This BE was prepared using biological assessment guidance provided by USFWS and the NMFS, as follows:

- A Guide to Biological Assessments, revised March 23, 1999, prepared by NMFS.[1]
- Biological Assessment Preparation and Review, revised October 20, 1999, prepared by USFWS.[2]

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[1] National Marine Fisheries Service, A Guide to Biological Assessments. revised March 23, 1999.

CHAPTER 1
PROJECT DESCRIPTION

Site Regulatory History

In 1983, Ecology and Environment, Inc., performed a site inspection (SI) for the United States Environmental Protection Agency (EPA) Region 10 under the Zone II Field Investigation Team contract. In August 1983, the McCormick & Baxter Creosoting Company performed a preliminary site investigation (AquaResources 1983) and notified the Oregon Department of Environmental Quality (DEQ) of possible off-site releases near a former waste disposal area. Subsequently, McCormick & Baxter contracted CH2M Hill to perform a site investigation, which was completed in 1985. CH2M Hill (1985, 1987) concluded that soil and groundwater contamination existed at the site but that no emergency actions were necessary to protect off-site populations.

On November 24, 1987, McCormick & Baxter and DEQ signed a Stipulation and Final Order, requiring McCormick & Baxter to perform specified remedial action (RA) activities. Not all of these requirements were completed by the time the facility was closed on October 10, 1991. DEQ conducted a remedial investigation/feasibility study (RI/FS) from September 1990 to September 1992 (PTI 1992a, 1992b). DEQ's investigations confirmed that soil, groundwater, and river sediment at the site are heavily contaminated with wood-treating chemicals.

DEQ issued a proposed cleanup plan in 1993. However, DEQ elected not to finalize the proposed RA at the McCormick & Baxter site in 1993 because of the pending addition of the site to the NPL by the United States EPA. DEQ instead implemented several interim removal action measures (IRAMs), which were elements of the 1993 DEQ proposed plan on the upland portion of the site. EPA added the site to the NPL on June 1, 1994.

Since completion of the RI/FS in 1992, DEQ has conducted several IRAMs and additional site characterization. Based on implementation and/or completion of the IRAMs, collection of additional site data since the 1992 RI/FS, and experience gained at other wood-treating sites, DEQ chose to revise the 1992 RI/FS to incorporate new data and updated remedial alternatives. A revised RI/FS report, which describes updated RA alternatives for the McCormick & Baxter site and incorporates IRAMs conducted since the 1992 FS, was issued in 1995 (PTI 1995).

A new proposed plan describing DEQ and EPA's preferred remedy was issued on October 30, 1995. A public comment period began on November 6, 1995, and ended on January 15, 1996. A public meeting was conducted on November 28, 1995. After considering the comments received during the public comment period, DEQ and EPA issued a record of decision (ROD), specifying the selected remedy, in March 1996. DEQ conducted public meetings on April 23 and May 29, 1996, to discuss the ROD and the

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[2] United States Fish and Wildlife Service, Biological Assessment Preparation and Review, revised October 20, 1999.

selected remedy. The ROD was amended in March 1998 to revise a portion of the soil remedy from on-site treatment to off-site disposal.

Selected Sediment Remedy

The selected remedy for the site includes capping sediment that contains contaminants above human health and ecological risk-based protective levels or that exhibits significant biological toxicity in the near surface. Additional components of the sediment remedy include:

- Sampling surface and near-surface sediment to determine contaminant concentrations and the level of attenuation of contaminant concentrations and toxicity since completion of the RI sediment monitoring and facility closure in 1991;

- Collection of Willamette River hydrodynamic data necessary for effective cap design and control of cap erosion;

- Long-term monitoring of the cap and surrounding areas following installation; and

- Institutional controls to ensure that the cap integrity is maintained.

Based on the results of the RI (PTI 1992a), it is estimated that the cap will cover approximately 15 acres and will extend along virtually the entire site shoreline, under the railroad bridge, and into the embayment to the north. The cap will consist of sand or other readily available clean fill suitable for placement in water. The cap will be at least 3 feet thick and may be armored in areas susceptible to erosion by river currents or vessel-induced wave action. The sediment cap design will be defined further after measurements of near-shore river circulation patterns, bottom water velocities, and near-shore wave heights are collected during remedial design (RD) and high river stage or flood events. The cap design will include provisions to:

- Ensure that the cap will be similar to existing sediment along the shoreline to preserve existing bottom habitat;

- Place structures necessary to maintain cap integrity (e.g., armored cap), but not create habitat for predators to prey on juvenile fish species; and

- Meet applicable or relevant and appropriate laws, regulations and standards, including Sections 401 and 404 of the Clean Water Act.

Sediment Remedial Action/Remedial Design Objectives

The remedial action objectives for sediment are the prevention of direct contact with contaminated sediment by humans and/or aquatic life and the minimization of releases of contaminants from the sediment that might result in contamination of the Willamette River in excess of federal and state ambient water quality criteria (AWQC).

The RD objective is to collect and present data necessary to design the cap. DEQ will prepare a means-and-methods (nonperformance) type of specification for the sediment cap.

To design the cap, the following field data are being obtained:

- Updated surface and underwater topography (bathygraphy), including location of structures (topography may have changed significantly since the February 1996 flood);
- The current extent of contamination in near-surface sediment (which may have changed significantly since 1990-91);
- Geotechnical characteristics of the sediment; and
- Verification of sediment cleanup goals for the protection of benthic organisms, based on a bioassay study.

Data acquisition will include sediment sampling for chemical and bioassay laboratory analyses, water sampling, physical analysis, and a bathymetric survey.

The current cleanup goals for sediment are designed to prevent direct human contact with sediment contaminated above the health-based levels and to prevent exposure of benthic organisms to sediment contaminated above known toxicity levels. No Oregon or federal freshwater sediment quality criteria exist; however, bioassay results in 1991 indicated that a substantial area of near-shore contaminated sediment is toxic to sedentary benthic invertebrates. These areas coincide with areas that exceed human health risk-based goals. In general, the human-health-based sediment cleanup goals are protective of benthic organisms; however, this will be verified with site-specific chemical and bioassay sediment data. If ROD cleanup goals (see Table 1) are found to not be protective of benthic organisms, more stringent sediment cleanup goals may be proposed by DEQ and EPA and a ROD amendment may be issued. DEQ is developing freshwater sediment criteria for the Portland Harbor, which may be applicable.

justify in more detail

Table 1 **Clean-Up Goals for Sediment** **McCormick & Baxter Creosoting Company Portland, Oregon**	
Compound	**Sediment Concentration (mg/kg, dry weight)**
Arsenic	12[a]
PCP	100[b]
Carcinogenic PAHs	2[b]
Dioxins/furans	0.008[b/c]

(a) Based on concentrations in upstream reference station.
(b) Based on an acceptable risk of 1×10^{6} for recreational exposure scenario. Exposure to sediment is not considered relevant to occupational scenarios. Exposure under the residential scenario would be similar to that assumed for the recreational scenario.
(c) Expressed as 2,3,7,8-TCDD toxic equivalent concentrations.

Key:
Dioxons/furans= Polychlorinated dibenzo-*p*-dioxins and dibenzofurans.
mg/kg= milligrams per kilogram.
PAHs= Polyaromatic hydrocarbons.
TCDD= Tetrachlorodibenzo-*p*-dioxin.
PCP= Pentachlorophenol.

CHAPTER 2
Environmental Baseline

Site Description

The McCormick & Baxter site (see Figure 1) is located on the Willamette River in Portland, downstream of Swan Island and upstream of the St. Johns Bridge. The Willamette River flows to the northwest adjacent to the site. The area was constructed by placement of dredged material sometime in the early 1900s. The site, which encompasses approximately 43 acres on land and 15 acres in the river, is generally flat and lies between a 120-foot-high bluff along the northeastern border and a 20-foot-high bank along the Willamette River to the southwest. A sandy beach is exposed at the base of the bank, except during brief periods of high river stage (generally late winter or early spring). The site is bordered by inactive industrial properties along the river and by a residential area on the bluff.

In the early 1900s, the first industrial structure, a sawmill, was built at the site. In 1944, the McCormick & Baxter Creosoting Company began wood-treating operations that continued until October 10, 1991. Four retorts at the site were used for various wood-treatment processes:

- Retort 1: Creosote in aromatic oils (1945 to 1991);

- Retorts 2 and 4: Pentachlorophenol (PCP) in aromatic oils (1953 to 1991);

- Retort 3: Water-based treatment (chromium from 1954 to 1970, ammoniacal copper arsenate from 1970 to 1986, and ammoniacal copper zinc arsenate from 1986 to 1991); and

- Retort 4: Cellon (PCP in liquid butane and isopropyl ether; 1968 to 1988).

A 750,000-gallon creosote tank and a diked tank farm with several additional tanks for storing wood-treatment chemicals were present at the site. Chemicals for water-based treatment also were stored in tanks near Retort 3. Chemicals remaining following shutdown of the site were inventoried and removed by DEQ in 1992 as an interim site stabilization action. All chemical storage tanks and retorts were cleaned, dismantled, and removed by DEQ in 1994.

From 1950 to 1965, waste oil-containing creosote and/or PCP was applied to site soil for dust suppression in the central process area. Liquid process wastes reportedly were discharged to a low area near the tank farm before 1971 (E & E 1983). Contaminated soil was removed from this area in the mid-1980s. From 1968 to 1971, process wastes were disposed of in the former waste disposal area in the northwest portion of the site. The site had a wastewater discharge outfall (Outfall 001) that was used to discharge cooling water when the plant was operating. Contact wastewater also was discharged from this outfall in the early years of operation. Three stormwater outfalls (Outfalls 002, 003, and 004) were also present along the river. Outfalls 001 and 002 were permitted under the National Pollutant Discharge Elimination System. Following plant shutdown, DEQ placed earthen berms around stormwater collection sumps at the site as an early response action to minimize off-site discharge. All four of these outfalls were removed as part of soil RA in early 1999. Currently, stormwater at the site infiltrates into the subsurface. The current configuration of the McCormick & Baxter property is shown in Figure 2.

Habitat Characterization

The National Oceanic and Atmospheric Administration (NOAA) characterized the site's habitat in a Preliminary Natural Resource Survey (September 1992), which is presented in Appendix B. NOAA also issued a Preliminary Natural Resource Survey for the Lower Willamette River (September 1999), which included a portion of the river adjacent to the McCormick & Baxter site. Habitats potentially at risk include the surface waters and associated bottom substrates of the lower Willamette River. Resources at risk include anadromous species, benthic invertebrates, and other resident species that provide a prey base and supporting habitat. The Willamette River is the second largest tributary of the Columbia River, and it supports large salmonid, shad, and sturgeon populations. Spawning of anadromous species occurs throughout the upper river basin, upstream of the McCormick & Baxter site. Substantial recreational fisheries are present on the river, and annual stocking programs are used to sustain salmonid populations within the basin. Juvenile salmonids use the lower Willamette River as a critical rearing habitat during their outmigration.

Several species of anadromous fishes, including Chinook salmon, steelhead, coho salmon, sockeye salmon, American shad, and white sturgeon, occur in the area. Juveniles and adults use the area as a migratory corridor and as rearing habitat. Cutthroat trout are also present, but their abundance is low, particularly in the lower Willamette River.

There are no commercial fisheries for the anadromous salmonids on the Willamette River. Recreational fishing is extremely popular throughout the lower Willamette Basin. Species most desired are spring Chinook, steelhead, coho, shad, and white sturgeon.

During the recently completed sediment investigation, 39 locations were sampled in the Willamette River near the McCormick & Baxter site. Approximately seven freshwater mollusk shells and two living mollusks were observed in sediments at nine locations. A single worm also was detected in another sample location. The benthic community appeared to be suppressed in the sampling area.

Habitat in the vicinity of the site has changed because of urban development and use of the river by the shipping industry. Dredging also has altered the riverbed, causing it to be steeply sloped with a sand and silt bottom.

Topography

The McCormick & Baxter property is located on a terrace that is generally flat, with surface elevations ranging from about 29 feet to 36 feet above mean sea level (AMSL [referenced to City of Portland datum]). The site is part of a larger industrial area that includes a former cooperage and shipyard to the northwest (Willamette Cove property) and the former Riedel International property to the southeast. The Burlington Northern Railroad (BNRR) tracks that border the site to the northwest are located on an embankment that is elevated approximately 40 feet above the site. The northeast side of the site is bordered by Union Pacific Railroad tracks and a naturally formed, 120-foot-high bluff. Atop this bluff is a residential area. A narrow, vegetated, 20-foot bank separates the site from the Willamette River to the southwest. A sandy beach is exposed at the base of the bank, except during periods in late winter or early spring when higher river stages (greater than 15 feet) prevail. Surveyed beach elevations generally range from 10 feet to 15 feet MSL.

Elevations on the site are generally highest at the base of the 120-foot-high bluff, ranging from 30 feet to 36 feet MSL, and gradually decrease toward the river. Elevations northwest of the central process area range from 33 feet to 36 feet MSL, except for the BNRR spur line, which slopes down to the site from the elevated BNRR mainline tracks. Southeast of the central process area, elevations generally range from 29 feet to 33 feet. The lowest elevations on site are along the southeastern fence line adjacent to the former Riedel International property and in the southeast waste disposal trench.

The McCormick & Baxter site is located at River Mile 7 on the Willamette River. Along this reach, the river flows to the northwest and is about 1,500 feet wide. Channel sounding maps for January 1991 from the United States Army Corps of Engineers (USACE) indicate that adjacent to the site, the channel is maintained at a width of approximately 600 feet and to a maximum depth of approximately 40 feet to 50 feet below the Columbia River datum. The Columbia River datum is 1.78 feet below the City of Portland datum that was used as a control for the site topographic survey. An additional 500-foot wide embayment exists along the south portion of the McCormick & Baxter property, with river depths in the embayment ranging from +10 to -25 feet (City of Portland datum). USACE maps indicate that steep slopes to the dredged navigational channel occur along a line approximately 150 feet southwest of the west corner of the site and to 300 feet southwest of the south corner of the site.

The elevation of the 100-year flood plain along this reach of the Willamette River is 28 feet (National Geodetic Vertical Datum [NGVD] 1929), and the elevation of the 500-year flood plain is 32 feet NGVD. The NGVD and City of Portland datums are approximately equal at the site. A 100-year flood would rise up the bank to within a few feet of the terrace. A storm event of this magnitude occurred in February 1996. A 500-year flood would encroach onto the southeast portion of the site, flooding most of the former untreated wood storage areas southeast of the tank farm and creosote tank.

Geology and Hydrology

The McCormick & Baxter site is located in an area of sand fill adjacent to the Willamette River. Three hydrostratigraphic units are present at the site: the shallow, intermediate, and deep aquifer zones, which are interconnected to varying degrees depending on the location within the site.

The shallow, unconfined, sand fill aquifer is present across the entire site and ranges in thickness from about 5 feet to greater than 30 feet. Depth of groundwater ranges from approximately 20 feet to 25 feet below ground surface (BGS). The base of the shallow aquifer is defined by a silt aquitard that ranges in thickness from 0 feet to greater than 100 feet. The silt aquitard is thickest near the central portion of the site in the tank farm area and thins toward the Willamette River. At the Willamette River, the silt aquitard is truncated and a thick sequence of poorly graded sands extends from ground surface to at least 80 feet BGS. In this area, the aquifer zones are hydraulically connected and form a single, continuous, unconfined aquifer near the river boundary. Depth intervals along the river are referred to as shallow, intermediate, and deep zones of a single aquifer that is separated into distinct aquifers landward.

The intermediate aquifer comprises fine- to medium-grained alluvial sand and is present below the silt aquitard. This aquifer varies in thickness from 0 feet to greater than 50 feet BGS. In the central process area, the intermediate aquifer is approximately 12 feet thick and is hydraulically separated from the shallow aquifer. In the tank farm area, the silt aquitard is greater than 100 feet thick and no intermediate aquifer is present. In other portions of the site, the intermediate zone is separated from the shallow zone by a thin silt aquitard and the intermediate zone is up to 50 feet or more in thickness. In these areas, the intermediate and deep zones are not separated by a continuous confining layer and apparently are in hydraulic connection.

The deep aquifer zone is present in all portions of the site. As described previously, the deep zone is in alluvial sands and is connected directly with the intermediate and shallow zones along the river margin. Near the center of the site, the deep zone is separated from the shallow zone by more than 100 feet of low-permeability silt. Near the bluff, the deep aquifer comprises gravel and sands of the Troutdale Formation and catastrophic flood deposits.

Groundwater gradients in the shallow, intermediate, and deep zones are generally from the bluff toward the river. However, there are periodic reversals of gradient from the river to the site, near the shoreline.

Surface Water

The Willamette River is the only surface water body at the site. Near the site, the river flows at a rate ranging from 8,300 cubic feet per second (cfs) in summer to 73,000 cfs in winter and is about 1,500 feet wide. The Willamette River is a major river that flows through Portland and joins the Columbia River approximately 7 miles northwest of the site. The Willamette River is not used as a drinking water source downstream of the site.

Climate and Meteorology

The temperature in the Portland area is generally mild, with little precipitation during spring and summer. Winter generally is characterized by mild temperatures, cloudy skies, and frequent rain. Monthly average temperatures range from approximately 41° Fahrenheit (F) in winter to approximately 70°F in summer. Daily minimum temperatures in January average 32°F. Daily maximum temperatures in July average 79°F. Average annual precipitation for Portland is 37.6 inches, with more than 76% of this falling between October and March. Monthly average relative humidity ranges from 65% to 84%.

Winds measured at the site average 4.7 miles per hour (mph). Monthly average wind speeds measured at the site are relatively constant, varying from 3 mph to 6 mph, but wind speeds are generally higher in summer than in fall and winter.

Wind directions measured at the site generally are aligned with the Willamette River Valley. The predominant wind direction through much of the year is from the north-northwest. During late fall and winter, however, winds shift so that the wind direction is generally from the southeast. This pattern is reflected in Portland International Airport data, although the directions are shifted slightly to reflect the differing orientations of the Columbia and Willamette River Valleys.

CHAPTER 3
Threatened and Endangered Species

The McCormick & Baxter property was a highly developed industrial area with little terrestrial wildlife habitat. The shoreline area provides habitat for benthic and aquatic species; however, the benthic community appeared to be suppressed as observed during recent sediment sampling.

Two federally endangered species have been observed at the site: the peregrine falcon *(Falco peregrinus)* and the bald eagle *(Haliaeetus leucocephalus).* The peregrine falcon was recently delisted (50 Code of Federal Regulations [CFR] 17, August 25, 1999) pursuant to the Endangered Species Act (ESA) of 1973, as amended. Protection of the peregrine falcon during ROD implementation would follow measures identified by the Migratory Bird Treaty Act (MBTA). The MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit (50 CFR 21.11). Implementation of the ROD would not violate the MBTA or cause a take of the species. The bald eagle (*Haliaeetus leucocephalus*) is a federally listed threatened species in Oregon. Oregon contains both resident and wintering populations of bald eagles.

The Lower Willamette River provides an adult and juvenile migratory corridor and juvenile rearing habitat for several anadromous fish species. These species are present in the river year-round as adults migrating upstream to spawn or juveniles migrating downstream to the ocean. Two runs of Chinook salmon, three runs of steelhead trout, and one run of coho occur in the area. Cutthroat trout are also present in the Willamette River, but their abundance is low (NOAA 1992).

Several of the evolutionarily significant units (ESUs) of the Willamette River either are listed or are proposed for listing under the ESA (50 CFR 17.11 and 17.12). These include ESUs of Chinook, steelhead, coho, and sea-run cutthroat for listed proposed and candidate species. The ESUs are described by the National Marine Fisheries Service (NMFS) in Appendix C.

On November 4, 1999, Ecology and Environment on behalf of DEQ submitted letters requesting species lists from the USFWS and NMFS. On November 10, 1999, NMFS responded by telephone with revision and concurrence on the proposed list and ESUs. A response from USFWS was received on December 9, 1999, and a copy of the letter is included in Appendix B.

CHAPTER 4
Description of Species and Habitat

Description of the Species and Habitat

Chinook: Spring and fall Chinook, differentiated by their time of entry into fresh water, use the Willamette River. The runs are genetically distinct from one another. During their annual migration, Willamette River spring Chinook begin entering the Columbia River during January. Peak densities occur in late March, with entries tapering off by mid-May. Spring Chinook migrate past the site, bound for upstream tributaries. Spawning takes place in the early fall. Wild juvenile spring Chinook reside in fresh water from three months to eighteen months following egg deposition. Emigration from natal streams occurs during one of three periods: (1) a movement of fry in late winter and spring soon after emergence (sub-yearlings); (2) a movement of yearlings in late fall and early winter; and (3) an emigration of smolts the following spring (Howell et al. 1985). Based on the number and small size of juveniles caught at collection facilities at Leaburg Dam on the McKenzie River, it is evident that many of the naturally produced spring Chinook in Willamette sub-basins emigrate to the lower reaches of tributaries and the main-stem Willamette River for completion of rearing before smoltification (Howell et al., 1988; Oregon Department of Fish and Wildlife [ODFW] 1990). They spend anywhere from one year to five years in the ocean (Bennett and Foster 1991).

Fall Chinook were introduced to the Willamette River in 1964. This sub-species spawns and rears in the main stem of the upper Willamette River and lower reaches of east-side tributaries upstream of the site. Fall Chinook begin entering the Columbia and Willamette Rivers in late August, and runs taper off by mid-October. The spawning period typically occurs from mid-September to late October. Wild fry begin emerging in late December. The migration of wild juveniles peaks the first week of June at Willamette Falls. Fall Chinook juveniles migrate to the Columbia River estuary as sub-yearlings (Howell et al. 1985). Fall Chinook generally spend two years to five years in the ocean before returning to the Willamette. Runs are supplemented by the addition of 5 million to 7 million hatchery smolts each year. Knutsen and Ward's (1991) study of the behavior of juvenile salmonids migrating through the Portland Harbor area found that yearling Chinook salmon appeared to be actively migrating through the area. Even during periods of low river flow, they did not spend more than a few days in the harbor area. Information regarding the migratory behavior of sub-yearling Chinook is limited. Sub-yearling Chinook were found in the harbor area over a longer period than other species or races of salmonids, probably because they actively feed during migration. There was little certainty regarding the extent to which they were actively migrating. Electrofishing catches from 1987 indicated that some juvenile salmonids may over-winter in the lower Willamette River.

Steelhead: Two races of steelhead are present in the Willamette River - winter run and summer run, each named for the time period in which spawning runs begin. The Willamette River winter steelhead run occurs during late winter to spring with adults migrating upstream from February through May. Spawning occurs from March through

May. Naturally spawned juveniles generally spend two years in fresh water before smolting. Out migration begins in early April and extends through June. Juvenile steelhead appear to actively migrate through the Portland Harbor area, spending less time in the area than other juvenile salmonids (Knutsen and Ward 1991). Runs have been supplemented by hatchery stocks since the 1960s. In 1991, approximately 565,000 winter steelhead smolts were released in the Willamette River basin as age 1+ smolts (Bennett and Foster 1991).

Summer steelhead begin entering the Willamette River starting in early March, migrating to spawning grounds above Willamette Falls. Peak migrations occur from mid-May through June. Adult fish remain in the river through fall and spawn during winter. Most returning adults spend two years in salt water. Summer steelhead were introduced above Willamette Falls in the late 1960's for sport fishing. Natural production is low and is monitored closely by ODFW to ensure that populations are sustained by hatchery releases and angling regulations. In 1991, approximately 750,000 hatchery-bred summer steelhead smolts were released in the Willamette Basin.

Coho: This species migrates up the Willamette from late August through early November with peak numbers beginning in mid- to late September. Spawning occurs from September through December, and juveniles migrate out the following spring. Coho return to fresh water as age-3 adults and age-2 jacks (precocious male adults). Because of concerns regarding competition between coho salmon and other game fish and a lack of contribution to Willamette River fisheries, the management of coho runs has been de-emphasized (Bennett and Foster 1991).

Sea-Run Cutthroat Trout: This species begins to congregate in estuaries and tidal water in July, preparing for their migration. The migration occurs in two groups: the first beginning in July and August, and the second in August and September. February is the peak spawning month, but spawning occurs from December though May. Spawning habitat for cutthroat trout includes shallow riffles with gentle gradient and clean pea-sized gravel.

Bald Eagle: The species is found throughout the Pacific Northwest, Alaska, Canada, the Rocky Mountains, the Great Lakes, Florida, and Chesapeake Bay. This species inhabits areas near large bodies of water with adequate supply of fish to eat and large trees sufficient for nesting and roosting. They also forage on small mammals, waterfowl, and carrion (Ehrlich et al. 1988). Generally, nesting activities occur in large conifers close to water. Winter roosting sites could be several miles from foraging areas and could occupy large conifers such as those within mature stands or old-growth conifers. Ecology and Environment and other contractors have observed bald eagles soaring in the vicinity of the project.

CHAPTER 5
Analysis of Effects

Potential Direct and Indirect Effects

The potential direct effect of placing the sediment cap would be an immediate loss of approximately 15 acres of bottom sediment habitat used by benthic invertebrates. However, as noted in Chapter 2, the benthic community appeared to be suppressed in the shoreline area. Conservation measures would include using in-kind material for the sediment cap and performing in-water work during agency work windows. Fish species using the area as a nursery or migratory corridor would be displaced temporarily during the in-water work. Conservation measures to reduce disturbance to fish would be to place the cap using methods to minimize disturbance of sediment and would be conducted in accordance with federal and state requirements established by appropriate resource agencies.

The proposed 3-foot sediment cap would change surface and underwater topography, leaving portions of the shoreline area exposed during high river stage. These portions normally are submerged during late winter and/or early spring. Shoreline water depth also would be decreased. These changes are not expected to effect species using the area or cause a loss of food supply. Benthic species would be expected to use the area again because in-kind material would be used for the cap design. Therefore, food sources for species using the area would be expected to remain similar to pre-cap conditions. The determination of effects are presented in Table 2.

In 1999, there were 376 bald eagle occupied breeding territories in the Columbia River Recovery Zone (Zone 10) which includes Oregon and the Washington portion of Zone 10. There are no documented bald eagle nests within the immediate vicinity of the project. The nearest nest site is located at Ross Island, T1S, R1E, Sec. 15. Because nesting activities do not occur in the immediate vicinity and no roosting sites have been observed onsite, project implementation would not result in disturbance to nesting or roosting activities and would pose no risk or mortality to the species. In-water work associated with placement of the cap could temporarily disturb or displace fish and waterfowl near the site, which could indirectly affect their foraging activities. However, the nearest nest site is at River Marker 15 and roosting activities have not been observed on site, therefore, adverse impacts are not likely.

Beneficial Effect

The aquatic environment along the shoreline is not functioning properly as defined by NMFS "A Guide to Biological Assessments".[3] The pathway of concern is water quality, with chemical contamination as the indicator. The system is not functioning properly based upon existing levels of arsenic, PCP, carcinogenic PAHs, and dioxins/furans in excess of federal and state ambient water quality criteria. Placement of the cap would eliminate pathways and would begin to restore the site to a properly functioning system.

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[3] National Marine Fisheries Service, A Guide to Biological Assessments. revised March 23, 1999.

This action would cause a beneficial effect to the environment by eliminating the chemical contamination pathways, thereby improving water quality.

Cumulative Effects

Future land use of the property has not yet been determined, but the property is zoned industrial. Future reuse of the site may be restricted somewhat by institutional controls, such as deed restrictions. In addition, measures to restrict or prohibit dredging will be pursued with USACE (the agency responsible for issuing dredge permits) and the property owner(s), to ensure long-term protection of the cap. Land use at the site has been industrial since the 1940s and has been projected to continue as industrial, or perhaps to change to recreational, in the future. Development of an industrial area is proposed at the former Riedel International property to the southeast, and development of a greenspace park is proposed by Metropolitan Service District (Metro) at the Willamette Cove property to the northwest. There are established railroad rights-of-way on two sides of the site, and it is anticipated that the area on top of the bluff will remain residential.

As previously described, the cumulative effects of the sediment cap are expected to be beneficial due to the reduced exposure pathway.

Interdependent/Interrelated Effects

Interdependent effects could include: (1) in-water work for placing the sediment cap; (2) maintenance and monitoring of the cap; (3) monitoring water quality and associated sampling activities; and (4) monitoring surface and underwater topography to ensure cap integrity. These activities are not expected to result in significant adverse impacts to listed species. Implementing the activities during agency work windows and following best management practices would reduce impacts.

Work associated with the removal of in-water structures and shoreline debris before placing the cap would include interrelated project effects. Removal of the former creosote pier structures and pilings, and possible armoring of areas surrounding the cap to reduce erosion caused by river currents or vessel-induced wave action are not expected to result in a significant adverse impact to species using the area. Pier pilings would not be removed completely but would be cut level with the existing bottom sediment. The purpose of this method is to reduce mobilization of contaminated sediment in the water column, and to prevent the establishment of conduits for contaminant migration.

Table 2 Determination of Effects McCormick & Baxter Creosoting Company Portland, Oregon			
Species	**Listing/Critical Habitat**	**ESU**	**Determination of Effects**
Chinook salmon	Threatened/Proposed	Lower Columbia and Upper Willamette River	May affect, not likely to adversely affect
Steelhead trout	Threatened/Proposed	Lower Columbia and Upper Willamette River	May affect, not likely to adversely affect
Sea-Run cutthroat trout	Proposed Threatened/None Proposed or Designated	Southwestern Washington/Columbia River	May affect, not likely to adversely affect
Coho salmon	Candidate/None Proposed or Designated	Lower Columbia River/Southwest Washington	May affect, not likely to adversely affect
Steelhead	Candidate/None Proposed or Designated	Oregon Coast	May affect, not likely to adversely affect
Bald eagle	Threatened/None Proposed or Designated	N/A	May affect, not likely to adversely affect
Peregrine falcon	Endangered/De-listed August 25, 1999	N/A	No effect

Key:
ESU= Evolutionarily significant units
N/A= Not applicable

CHAPTER 6
Management Actions

Engineering and institutional controls, such as perimeter fencing and warning signs, are already in place and would be maintained until completion of the cleanup. The upland portion of the site is surrounded by a chain-link fence with posted warning signs. In addition, large signs posted along the riverbank provide notice of site contamination and warnings against fishing and swimming in the river. A security guard also patrols the site during evenings and weekends.

A portion of the contaminated sediment is located north of the Burlington Northern railroad trestle. DEQ will notify USACE and the Division of State Lands (DSL) of the existence of the cap. Measures to restrict or prohibit dredging will be pursued with USACE (the agency responsible for issuing dredging permits) and the property owner(s) to ensure long-term protection of the cap.

Long-term institutional controls may include deed notices containing information regarding the levels and location of contamination on the property. Deed restrictions such as environmental easements or restrictive covenants limiting future site use to industrial or recreational activities may be applied to the upland portion of the site. The deed restrictions would prohibit future uses not consistent with the level of protectiveness achieved by the cleanup.

Regular, visual inspections of the cap, focused along the perimeter where erosional forces could be highest, will ensure that the cap remains intact and effective. The cap will be inspected regularly during the first five years after installation and after any major or 100-year flood event to verify that physical integrity of the cap remains intact and necessary repairs will be performed. Inspection frequencies then could be reassessed based on previous inspections and observation from the previous five years. Long-term monitoring will be conducted to ensure timely maintenance of the sediment cap and that the cap performs as expected in the long term.

If contamination is detected migrating through the cap at levels exceeding sediment cleanup goals then contingency plans such as adding an additional layer of cap material to further buffer the contaminants from the river or evaluating alternative capping material would be implemented. If sediment monitoring indicates contamination above the sediment cleanup goals outside the cap boundary, the cap will be extended to cover the contamination to the extent feasible.

is this really possible.

CHAPTER 7
Conclusion

The effects determination of "may affect, not likely to adversely affect" regarding the selected remedy will protect listed, proposed, and candidate endangered species by ensuring the following:

- The selected remedy of capping contaminated sediment along the shoreline would be a beneficial effect by improving habitat, eliminating the direct contact and ingestion exposure pathways for aquatic species, and decreasing the potential release of contaminants from the sediment into the water column of the Willamette River;

- Information regarding fish inventories and surveys in the Willamette River was collected using available literature. Fish utilization of the Willamette River occurs year-round, either as a nursery or a migratory corridor. Agency work windows would be followed to reduce impacts to fish transiting in the vicinity of the site; - specifics on how

- Existing habitat along the shoreline would remain the same because in-kind material would be used for the sediment cap; - verify

- DEQ would notify USACE and DSL of the existence of the cap. Measures to restrict or prohibit dredging will be pursued with USACE (the agency responsible for issuing dredging permits) and the property owner(s) to ensure long-term protection of the cap;

- Regular inspections of the cap, focused along the perimeter where erosional forces could be highest, would ensure that the cap remains intact and effective;

- Long-term monitoring would be conducted to ensure that the sediment cap performs as designed in the long term, and to ensure timely maintenance of sediment cap, if necessary;

- A contingency plan would be implemented if contamination that exceed cleanup goals is detected; and

  1st mention - so explanation more detailed earlier,

- Structures necessary to maintain cap integrity (e.g. armored areas) would be placed and/or designed to avoid creating areas of cover that could increase predators to juvenile fish species.

References

AquaResources, Inc., 1983, *Summary of Soil and Groundwater Quality Data Portland Plant*, Berkeley, California.

Bennett, D.E. and C.A. Foster. 1991. 1990 Willamette River Spring Chinook Salmon Run, Fisheries, and Passage at Willamette Falls. Oregon Department of Fish and Wildlife, Columbia River Management. Portland, Oregon.

CH2M Hill, 1987, *McCormick & Baxter Creosoting Co. Portland Plant: Environmental Contamination Site Assessment and Remedial Action Report, Volume 1*, submitted to Oregon Department of Environmental Quality (DEQ), Portland, Oregon, prepared by McCormick & Baxter Creosoting Company and CH2M Hill, Portland, Oregon.

CH2M Hill, 1985, *McCormick & Baxter Creosoting Company Site Water and Soil Investigation, Interim Report*, submitted to DEQ, Portland, Oregon.

Ecology and Environment, 1983, *Site Inspection, McCormick & Baxter Creosoting Company*, prepared for EPA, Region 10, Seattle, Washington.

Ehrlich, P.R., Dobkin D.S., and Wheye D. 1988, *The Birder's Handbook: A Field Guide to the Natural History of North American Birds*, Simon and Schuster, New York, New York.

Howell, P., K. Jones, D. Scarneccia, L. LaVoy, W. Kendra, and D. Ortman. 1985. Stock Assessment of the Columbia River Anadromous Salmonids; Volume I: Chinook, Coho, Chum, and Sockeye Salmon Stock Summaries. Project No. 83-335. Report prepared under contract to Bonneville Power Administration, Portland, Oregon.

Howell, P., J. Hutchison, and R. Hooten. 1988. McKenzie Subbasin Fish Management Plan. Oregon Dept. of Fish and Wildlife.

Isaacs, F.B., and Anthony R.G. 1999. *Bald Eagle Nest Locations and History of Use in Oregon and the Washington Portion of the Columbia River Recovery Zone*, 1971 through 1999, Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, Oregon.

Knutsen, C.S. and D.L. Ward, 1991, *Behavior of juvenile salmonids migrating through the Willamette River near Portland, Oregon*, Oregon Department of Fish and Wildlife, Portland, Oregon.

National Marine Fisheries Service, A Guide to Biological Assessments. revised March 23, 1999.

NOAA, Preliminary Natural Resource Survey. September 8, 1999.

APPENDIX A

Site Photographs
1 to 4

McCormick & Baxter Creosoting Company
6900 North Edgewater Street
Portland, Oregon

Shoreline Cap Area

Photograph 1: Looking North from proposed sediment cap. Willamette River in background and Burlington Northern Rail Road located in top portion of photograph. Monitoring well number 25 located in left portion of photograph.

McCormick & Baxter Creosoting Company
6900 North Edgewater Street
Portland, Oregon

Shoreline Cap Area

Photograph 2: Looking northwest from proposed sediment cap. Willamette River in background and Burlington Northern Rail Road located in top portion of photograph.

McCormick & Baxter Creosoting Company
6900 North Edgewater Street
Portland, Oregon

Shoreline Cap Area

Photograph 3: Looking south from proposed sediment cap. Monitoring well number 31 is located in center of photograph.

McCormick & Baxter Creosoting Company
6900 North Edgewater Street
Portland, Oregon

Shoreline Cap Area

Photograph 4: Looking west from proposed sediment cap. Pipe in center of photograph is the NPDES outfall for treated groundwater.

APPENDIX B

Agency Correspondence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon State Office
2600 S.E. 98th Avenue, Suite 100
Portland, Oregon 97266
(503) 231-6179 FAX: (503) 231-6195

Reply To: 1-7-00-SP-045
File Name: SP045.WPD

December 9, 1999

Noreen Roster
Ecology and Environment, Inc.
333 SW Fifth Avenue
Portland, OR 97204

Dear Ms. Roster:

This is in response to your letter, dated November 2, 1999, requesting information on listed and proposed endangered and threatened species that may be present within the area of the McCormick and Baxter Creosoting Company Site Restoration project in Multnomah County. The U.S. Fish and Wildlife Service (Service) received your letter on November 4, 1999.

We have attached a list (Attachment A) of threatened and endangered species that may occur within the area of the McCormick and Baxter Creosoting Company Site Restoration project. The list fulfills the requirement of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Environmental Protection Agency (EPA) requirements under the Act are outlined in Attachment B.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems on which they depend may be conserved. Under section 7(a)(1) and 7(a)(2) of the Act and pursuant to 50 CFR 402 *et seq.*, EPA is required to utilize their authorities to carry out programs which further species conservation and to determine whether projects may affect threatened and endangered species, and/or critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) which are major Federal actions significantly affecting the quality of the human environment as defined in NEPA (42 U.S.C. 4332 (2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to the Biological Assessment be prepared to determine whether they may affect listed and proposed species. Recommended contents of a Biological Assessment are described in Attachment B, as well as 50 CFR 401.12.

If EPA determines, based on the Biological Assessment or evaluation, that threatened and endangered species and/or critical habitat may be affected by the project, EPA is required to consult with the Service following the requirements of 50 CFR 402 which implement the Act.

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Attachment A also includes a list of candidate species under review for listing. The list reflects changes to the candidate species list published September 19, 1997, in the Federal Register (Vol. 62, No. 182, 49398) and the addition of "species of concern." Candidate species have no protection under the Act but are included for consideration as it is possible candidates could be listed prior to project completion. Species of concern are those taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

If a proposed project may affect candidate species or species of concern, EPA is not required to perform a Biological Assessment or evaluation or consult with the Service. However, the Service recommends addressing potential impacts to these species in order to prevent future conflicts. Therefore, if early evaluation of the project indicates that it is likely to adversely impact a candidate species or species of concern, EPA may wish to request technical assistance from this office.

Your interest in endangered species is appreciated. The Service encourages EPA to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact Angie Hernandez or Laura Todd at (503) 231-6179. For questions regarding anadromous fish, please contact National Marine Fisheries Service, 525 NE Oregon St., Suite 500, Portland, Oregon 97232, (503) 230-5400. All correspondence should include the above referenced file number.

Sincerely,

Nancy K. Lee

Acting State Supervisor

Attachments
SP 045
cc: PFO-ES
ODFW (nongame)

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN THAT MAY OCCUR WITHIN THE MCCORMICK AND BAXTER CREOSOTING COMPANY SITE RESTORATION PROJECT AREA
1-7-00-SP-045

LISTED SPECIES[1/]

Birds		
Bald eagle	*Haliaeetus leucocephalus*	T
Fish		
Chum salmon (Lower Columbia River)[2/]	*Oncorhynchus keta*	**T
Steelhead (Upper Willamette River)[3/]	*Oncorhynchus mykiss*	**T
Steelhead (Lower Columbia River)[4/]	*Oncorhynchus mykiss*	**T
Chinook salmon (Lower Columbia River)[5/]	*Oncorhynchus tshawytscha*	**T
Chinook salmon (Upper Willamette River)[5/]	*Oncorhynchus tshawytscha*	**T
Plants		
Golden paintbrush[6/]	*Castilleja levisecta*	T
Howellia	*Howellia aquatilis*	T
Bradshaw's lomatium	*Lomatium bradshawii*	E
Nelson's checker-mallow	*Sidalcea nelsoniana*	T

PROPOSED SPECIES

Fish		
Coastal cutthroat trout (Lower Columbia River)	*Oncorhynchus clarki clarki*	PT
Plants		
Willamette daisy[7/]	*Erigeron decumbens* var. *decumbens*	PE
Kincaid's lupine[7/]	*Lupinus sulphureus* var. *kincaidii*	PT

CANDIDATE SPECIES

Amphibians and Reptiles		
Oregon spotted frog[8/]	*Rana pretiosa*	
Fish		
Coho salmon (Lower Columbia River)[9/]	*Oncorhynchus kisutch*	**CF

SPECIES OF CONCERN

Mammals	
Pacific western big-eared bat	*Corynorhinus (=Plecotus) townsendii townsendii*

Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
<u>Birds</u>	
Tricolored blackbird	*Agelaius tricolor*
Little willow flycatcher	*Empidonax traillii brewsteri*
<u>Amphibians and Reptiles</u>	
Northwestern pond turtle	*Clemmys marmorata marmorata*
Northern red-legged frog	*Rana aurora aurora*
<u>Fish</u>	
Pacific lamprey	*Lampetra tridentata*
<u>Invertebrates</u>	
California floater (mussel)	*Anodonta californiensis*
<u>Plants</u>	
Howell's bentgrass	*Agrostis howellii*
White top aster	*Aster curtus*
Tall bugbane	*Cimicifuga elata*
Pale larkspur	*Delphinium leucophaeum*
Peacock larkspur	*Delphinium pavonaceum*
Howell's montia	*Montia howellii*
Columbia cress	*Rorippa columbiae*
Oregon sullivantia	*Sullivantia oregana*

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

(CF) - Candidate: National Marine Fisheries Service designation for any species being considered by the Secretary for listing for endangered or threatened species, but not yet the subject of a proposed rule.
*** Consultation with National Marine Fisheries Service required.*

1/ U. S. Department of Interior, Fish and Wildlife Service, October 31, 1997, <u>Endangered and Threatened Wildlife and Plants</u>, 50 CFR 17.11 and 17.12.
2/ Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Columbia River Chum Salmon
3/ Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead
4/ Federal Register Vol. 63, No. 53, March 19, 1998, Final Rule-West Coast Steelhead
5/ Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon
6/ Federal Register Vol. 62, No. 112, June 11, 1997, Final Rule-Castilleja levisecta
7/ Federal Register Vol. 63, No. 17, January 27, 1998, Proposed Rule-Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii and Fender's blue butterfly.
8/ Federal Register Vol. 62, No. 182, September 19, 1997, Notice of Review-Candidate or Proposed Animals and Plants
9/ Federal Register Vol. 62, No. 87, May 6, 1997, Final Rule-Coho Salmon

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ATTACHMENT B

FEDERAL AGENCIES RESPONSIBILITIES UNDER SECTION 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a)-Consultation/Conference

Requires:

1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat. The process is initiated by the Federal agency after they have determined if their action may affect (adversely or beneficially) a listed species; and

3) Conference with FWS when a Federal action is likely to jeopardize the continued existence o f a proposed species or result in destruction or adverse modification of proposed Critical Habitat.

SECTION 7(c)-Biological Assessment for Major Construction Projects[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify and proposed and/or listed species which are/is likely to be affected by a construction project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct and on-site inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or for potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within FWS, National Marine Fisheries Service, State conservation departments, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures and (6) prepare a report documenting the results, including a discussion of study methods used, nay problems encountered, and other relevant information. The BA should conclude whether or not a listed species will be affected. Upon completion, the report should be forwarded to our Portland Office.

---

[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332. (2)c). On projects other that construction, it is suggested that a biological evaluation similar to the biological assessment be undertaken to conserve species influenced by the Endangered Species Act.

NOAA PRELIMINARY NATURAL RESOURCE SURVEY

Lower Willamette River
Portland, Oregon
September 8, 1999

Site ID: 3R

FINDINGS OF FACT

SITE OVERVIEW

The lower Willamette River is a highly industrialized waterway that supports an active shipping industry and diverse urban development. The area of concern is a six-mile section of the lower river where discharges and spills have contaminated sediments with polynuclear aromatic hydrocarbons (PAHs), trace elements, and pesticides. Seventeen sites have been identified as potential sources of contamination to the river, but sediment investigations indicate the contamination beyond the areas adjacent to these sites. The area is being evaluated as a candidate for inclusion on the U.S. EPA National Priorities List.

The Willamette River is an important fish stream with spawning populations of chinook and coho salmon, steelhead, American shad, Pacific lamprey, and white sturgeon. The lower Willamette River upstream to the Willamette Falls provides a migratory corridor for both juvenile and adult anadromous fish and juvenile rearing habitat for several anadromous fish species. Three runs of chinook, two runs of steelhead, and individual runs of coho and sockeye salmon occur in the area. Several of these runs are either listed or proposed for listing under the Endangered Species Act. Pacific lamprey is classified as a species of special concern because of declining populations.

The contaminants of concern in the lower Willamette River are PAHs, polychlorinated biphenyls (PCBs), trace elements, organotins, and chlorinated pesticides. PAHs are ubiquitous at highly elevated concentrations in the sediments of three of five reaches in the lower river. Trace elements are ubiquitous at lower concentrations, but are elevated near specific sites. Pesticides have also been detected near an agricultural chemical plant. All of the substances of concern have been detected in the river sediments at concentrations shown to cause adverse effects in aquatic organisms in other studies. Invertebrate toxicity due to sediment exposure has been demonstrated in limited laboratory bioassays, but toxicity to fish has not been determined.

SITE HISTORY

The Willamette River originates in the Cascade Mountain Range and flows approximately 187 miles north before discharging to the Columbia River. The six-mile study area has been divided into five reaches to facilitate environmental investigations. The lower Willamette River study area extends from river mile (Rm) 3.5 to Rm 9.5 (Weston 1998; Figure 1).

Much of the upland areas adjacent to the Willamette River within the study area are heavily industrialized, and marine traffic within the river is considered intensive. The river shore has been altered to accommodate urban development and a growing shipping industry. Steeply sloped banks covered with riprap or constructed bulkheads, piers, or wharves characterize the shoreline. Industrial operations in the study area include hazardous waste storage, marine construction, bulk petroleum product storage and handling, wood treating, agricultural chemical production, battery processing, chlorine production, and ship maintenance and repair (Weston 1998).

Seventeen industrial sites have been identified as potential sources of contamination to the sediments in the Willamette River study area (Table 1). Past investigations have found numerous industrial contaminants in site soils and river sediment including PAHs, pesticides, PCBs, dioxins, trace elements, organotins, pentachlorophenol, and solvents. Contaminants have likely entered the river via accidental spills, direct discharge, contaminated groundwater discharge, surface water and stormwater runoff, or contaminated soil erosion (Weston 1998).

The Willamette River study area is being evaluated for potential inclusion onto the EPA National Priorities List of hazardous waste sites. A Site Inspection (SI) for the study area was conducted in 1997 and the SI Report was completed in 1998 (Weston 1998).

PATHWAY CHARACTERIZATION

Source and pathway investigations were not conducted as part of Site Inspection activities. However, most industrial activity in the area takes place within 300 m of the river shore and discharges to the river occur via outfalls, direct discharge, and spills (Weston 1998).

Surface Runoff Pathway

Surface runoff pathways have not been investigated area-wide, but information indicates that direct surface discharges are a significant contributor of site-related contaminants to the lower Willamette River. Fuel and other hydrocarbon spills have been documented at the Time Oil Northwest and Linnton Terminals, Terminal 4 - Port of Portland, Mobil Oil Bulk Plant, and Elf Atochem. Direct discharge of fuel or sandblast wastes have been reported at the following facilities: U.S. Moorings, GASCO, McCormick and Baxter, Rhone-Poulenc, Gould, Inc., Elf Atochem, Port of Portland Ship Repair, and Gunderson, Inc. Leaking underground storage tanks have been reported at Reidel Environmental Services, and Gunderson, Inc. (Weston 1997).

Groundwater Pathway

The groundwater pathway to the Willamette River has not been investigated across the entire study area, but as reported, most of the sites are adjacent to or within 300 m of the river shore. Nearshore sediments may capture areas of significant groundwater contamination (Weston 1998). Leaking underground storage tanks have been reported at Reidel Environmental Services at Gunderson, Inc. (Weston 1997).

POTENTIALLY EXPOSED RESOURCES

Habitats potentially at risk include the surface waters and associated bottom substrates of the lower Willamette River. Resources at risk include anadromous species, benthic invertebrates, and other resident species that provide a prey base and supporting habitat. The Willamette River is the second largest tributary of the Columbia River and it supports large salmonid, shad, and sturgeon populations. Spawning of anadromous species occurs throughout the upper river basin, upstream of the study area. Substantial recreational fisheries are present on the river and annual stocking programs are currently used to sustain salmonid populations within the basin (Foster personal communication 1998).

Juvenile salmonids use the lower Willamette River as a critical rearing habitat during their outmigration. Trust resources may be at risk by remaining for long periods in the study area during sensitive early life stages.

Habitat Characterization

The Willamette River originates in the Cascade Range and flows north for approximately 300 km before discharging into the Columbia River, 160 km upstream from the Pacific Ocean. Surface waters in the study area are tidal freshwater (Foster personal communication 1998). Channel depths range from 3 to 42 m with an average depth of 13.6 m (Weston, 1998). Mean river flow is 31,370 cubic feet per second (cfs) with monthly flow ranging from 7,626 cfs in August to 44,190 cfs in December (USGS 1998).

Lower Willamette River habitat in the study area has been altered to accommodate urban development and a growing shipping industry. Development in the harbor has replaced the natural shoreline with riprap, bulkheads, other artificial structures, and sand-beached lagoons. Because of dredging, the river has a steeply sloped, silt and sand bottom (PTI 1992).

Resource Utilization

Several species of anadromous fishes, including chinook salmon, steelhead, coho salmon, sockeye salmon, American shad, and white sturgeon occur in the area. Both juveniles and adults use the study area as a migratory corridor and as rearing habitat by juveniles. Cutthroat trout are also present, but their abundance is low, particularly in the lower Willamette River (Bennett and Foster 1991; Foster personal communication 1998).

Chinook salmon

Two genetically distinct stocks of chinook salmon—spring chinook and fall chinook—use the Willamette River. The stocks are named for the period in which they enter fresh water.

During their annual migration, Willamette River spring chinook begin entering the Columbia River during January. Peak densities occur in late March, with entries tapering off by mid-May. Spring chinook migrate past the site, bound for upstream tributaries. Spawning takes place in the early fall.

Wild juvenile spring chinook reside in fresh water from 3 to 18 months following egg deposition. Emigration from natal streams occurs during one of three periods: (1) a movement of yearlings in late winter and spring soon after emergence (subyearlings); (2) a movement of yearlings in late fall and early winter; and (3) an emigration of smolts the following spring (Howell et al. 1985). Based on the small size of juveniles caught at collection facilities at Leaburg on the McKenzie River, it is probable that many of the naturally produced spring chinook in Willamette sub-basins emigrate to the lower reaches of tributaries and the mainstem Willamette River to complete rearing before smolting (ODFW 1990). Chinook reside in the ocean for 1 to 5 years before returning to spawn (Bennett and Foster, 1991).

Five large hatcheries produce approximately 5 to 6 million smolt-size spring chinook for release into the Willamette River each year, plus additional fingerling salmon to seed under-used reservoir and tributary streams. Current hatchery practices include the release of one-third of the annual production as subyearlings in November and two-thirds as moderate-sized yearlings (smolts) in March. Subyearlings are released into streams or reservoirs for further rearing. Most of the smolts are released near the adult collection sites, but some are also trucked to areas within the lower Willamette River to increase survival (Foster personal communication 1998).

A stock of fall chinook was introduced to the Willamette River in 1964. This stock spawns and rears in the mainstem of the upper Willamette River and lower reaches of east-side tributaries upstream of the site. Fall chinook begin entering the Columbia and Willamette rivers in late August and runs taper off by mid-October. Spawning typically occurs from mid-September to late October (Bennett and Foster 1991). Wild fry begin emigrating in late December. The migration of wild juveniles peaks the first week of June at Willamette Falls. Fall chinook juveniles migrate to the Columbia River estuary as subyearlings (Howell, et al. 1985). Fall chinook generally spend two to five years in the ocean before returning to spawn. The fall chinook run had primarily been maintained by a hatchery program, but was discontinued in 1996, because of budgetary constraints and lack of importance in the Willamette basin. Natural spawning is expected to continue in the upper river, but at diminished numbers (Foster personal communication 1998).

Knutsen and Ward's (1991) study of the behavior of juvenile salmonids migrating through the Portland Harbor area found that subyearling chinook salmon appeared to be actively migrating through the area. Even during periods of low river flow, they did not spend more than a few days in the harbor area. Information on the migratory behavior of subyearling chinook is limited. Subyearling chinook were found in the harbor area over a longer period than other species or races of salmonids, probably because they actively fed during migration. There was little certainty to what extent they were actively migrating. Electrofishing catches from 1987 indicated that some juveniles might over-winter in the lower Willamette River.

Steelhead

There are two stocks of steelhead on the Willamette River, winter and summer run, named for the time period in which spawning runs begin. The Willamette River winter steelhead run occurs during the late winter to spring, with adults migrating upstream from February through May. Spawning occurs from March through May. Naturally spawned juveniles generally spend two years in fresh water before smolting; out-migration begins in early April and extends through June (Bennett and Foster 1991). Juvenile steelhead appear to actively migrate through the Portland Harbor area, spending less time in the area than other juvenile salmonids (Knutsen and Ward 1991). Hatchery stocks have supplemented runs since the 1960s, but this practice is in the process of modification due to the recent listing of the wild steelhead on the endangered species list (Foster personal communication 1998).

Summer steelhead begin entering the Willamette River starting in early March migrating to spawning grounds above Willamette Falls. Peak migrations occur from mid-May through June. Adult fish remain in the river through the fall and spawn during the winter months. The majority of returning adults spend two years in saltwater. Summer steelhead were introduced above Willamette Falls in the late 1960s for sport fishing. Natural production is low. The Oregon Department of Fish and Wildlife closely monitors production to ensure that populations are sustained by hatchery releases and angling regulations (Foster personal communication 1998).

Coho salmon

Coho migrate up the Willamette from late August through early November with peak numbers beginning in mid- to late September. Spawning occurs from September through December and juveniles outmigrate the following spring. Coho return to freshwater as age-3 adults and age-2 jacks (precocious male adults). Due to concerns regarding competition between coho salmon and other game fish and a lack of contribution to Willamette River fisheries, the management of coho runs has been de-emphasized (Foster personal communication 1998).

Sockeye salmon

Small numbers of sockeye salmon return to the Willamette River. Juvenile sockeye salmon were introduced into several reservoirs in the upper reaches of the Willamette and Santiam rivers in the 1950s. Presumably, the downstream migration of some individuals derived from these transplants led to returns of anadromous sockeye salmon (Foy et al. 1995).

American shad

American shad are not indigenous to the Willamette River, but were introduced to the Columbia basin in the late 1800s. Shad enter the lower Willamette River and migrate upstream to Willamette Falls from mid-May to mid-July, peaking in June. Shad rarely use the Willamette Falls fishway due to structural limitations that inhibit the species from proceeding upstream. Data for sport catch indicate that shad are abundant in the Willamette River, but spawning location and general resource use by the species is unclear. Shad are broadcast spawners, releasing eggs into open water. The eggs are only slightly heavier than water and non-adhesive; they settle and are carried along by the current. Larvae hatch in eight to twelve days and spend their first summer in fresh water. They drift downstream and enter the ocean in autumn (Scott and Crossman 1973). Management of the underused shad fishery is considered unnecessary (Foster personal communication 1998).

White sturgeon

White sturgeon are plentiful throughout the lower Willamette River, and transplants have established a small resident population above Willamette Falls. Most white sturgeon spawn immediately below Willamette Falls, upstream of the site, during the late fall and winter. Juveniles are present in the river year round and congregate in the Portland area near the site. Sturgeon have been stocked in limited numbers (approximately 1,000 to 2,000 per year) above the falls for the last three years (Bennett and Foster 1991; Foster personal communication 1998).

Juvenile salmonid diet in soft-bottom freshwater environments

Juvenile salmonids are habitat opportunists, feeding on benthic and drift organisms in freshwater environments as they migrate downstream (Becker 1973). Feeding habits have been shown to differ from watershed to watershed (McCabe et al. 1983). In tidal freshwater areas of the Columbia River, the amphipods *Corophium salmonis* and *C. spinicorne* are the principal prey of ~~subyearling chinook, coho, and~~ steelhead juveniles. These amphipods are critical to juvenile salmonids below the Bonneville Dam. Biological assessments to determine their potential impact is necessary before areas can be used to dispose of dredged materials (McCabe and Hinton 1996). Amphipods are very common in tidal freshwater areas of the Columbia estuary, and are an important prey of juvenile salmonids up to the Bonneville Dam (upstream of the mouth of the Willamette River). However, there has been no broad characterization of the complete benthic community in the tidal Willamette River. Limited benthic sampling shows that *C. salmonis* was one of the five dominant taxa at Rm 1 and at 9, but not at Rm 6 (Tetra Tech 1993)

Chironomid larvae, *Daphnia* spp., and adult dipteran insects also composed significant portions of juvenile salmon diets in freshwater areas of the Columbia River estuary (McCabe et al. 1983). In the central Columbia River, juvenile chinook salmon consumed almost entirely adult and larval stages of aquatic insects dominated by chironomids (75-81 percent; Becker 1973).

Threatened or Endangered Species

Several of the anadromous fish runs (considered evolutionarily significant units; ESUs) in the area are either listed or proposed for listing under the Endangered Species Act (50 CFR 17.11 and 17.12). Steelhead from Willamette River tributaries downstream of Willamette Falls are included in the Lower Columbia River ESU, listed as a threatened species in March 1998. Steelhead from Willamette River tributaries upstream of Willamette Falls are included in the Upper Willamette ESU, listed as a threatened species in March 1999. Spring chinook salmon from Willamette River tributaries downstream of Willamette Falls are included in the Lower Columbia River ESU, listed as a threatened species in March 1999. Spring chinook salmon from Willamette River tributaries upstream of Willamette Falls are included in the Upper Willamette River ESU, listed as a threatened species in March 1999. Coho salmon from Willamette River tributaries downstream of Willamette Falls are included in the Lower Columbia River ESU, a candidate species for listing. Sea-run cutthroat in Willamette River tributaries downstream of Willamette Falls are included in the Southwestern Washington/Columbia River ESU, proposed for listing as a threatened species in March 1999. Listing assessments for candidate species are expected by mid-1999. Final listing determinations for proposed species are expected in April 2000. A threatened species is defined as a species that is likely to become endangered in the foreseeable future (Federal Register 1998).

The U.S. Fish and Wildlife Service (USFWS) classifies Pacific lamprey as a species of special concern. The USFWS defines species of special concern as those organisms whose conservation status is of concern to the USFWS, but for which further information is needed. The Oregon Fish and Wildlife Commission also classifies Pacific lamprey as a sensitive species. The state of Oregon defines a sensitive species as a naturally reproducing native vertebrate that is likely to become threatened or endangered throughout all or a significant portion of its range in Oregon. The Sensitive Species List explicitly encourages actions that will prevent further decline in species populations and/or habitats and thus avoid the need for listing (Weston 1998).

Commercial and Recreational Fisheries

There are no commercial fisheries for the anadromous salmonids on the Willamette River (Foster personal communication 1998). The Columbia River supports a valuable commercial fishery. Because of precipitous declines in stocks, stock-preservation activities, competing fishing gears, and conflicting uses of the Columbia River (e.g., hydropower and shipping), commercial fisheries are highly regulated in that river (Bennett and Foster 1991).

Recreational fishing is extremely popular throughout the lower Willamette basin. Species most desired are spring chinook, steelhead, coho, shad, and white sturgeon (Foster personal communication 1998). Spring chinook contribute substantially to the mainstem Columbia River sport fishery and consistently support the largest recreational fishery in the lower Willamette River. The chinook fishery in the Willamette River occurs between Oregon City and the confluence of the Willamette and Columbia rivers, and throughout the Multnomah Channel. The study area is located within this 75-km reach, and recreational angling may occur within areas of concern. Angling is conducted primarily from anchored or slow-moving boats (Bennett and Foster 1991; Foster personal communication 1998).

Peak effort for white sturgeon occurs during the spring and summer months of this year-round fishery. Although estimates were not available, harvest of legal-sized sturgeon is considered to be less than 1,000 individuals per year. Most sturgeon angling is upstream near Willamette Falls (Bennett and Foster 1991; Foster personal communication 1998).

Fishing Advisories

The Willamette River has two fishing advisories. One advisory is for arsenic, creosote, and pentachlorophenol in crustaceans and crayfish near the McCormick and Baxter site. The other advisory is for mercury in large- and smallmouth bass and squawfish in the mainstem of the Willamette River.

Indian Tribal Fisheries

Indian treaty rights on Willamette River salmonids may be asserted off the coast of Washington and also in the Lower Columbia and Willamette rivers. The general rule, established in the ongoing litigation known as U.S. v. Washington and U.S. v. Oregon, is that treaty Indian tribes have a right to half the fish that, absent prior interception, would pass through their usual and accustomed fishing grounds and stations (commonly known as u&a grounds). Under CERCLA, Indian tribes are natural resource trustees for these fisheries resources (42 U.S.C. 9607(f)(1) and 40 C.F.R. 300.610.)

Washington Coast: Willamette spring chinook travel north after they exit the Columbia River, pass through the Washington coastal tribes ocean u&a grounds, and return along the same route when they are ready to spawn. The Washington coastal tribes are the Makah, Quileute, Hoh, and Quinault. The Makah Tribe's ocean u&a grounds have been adjudicated, and all four tribes' ocean u&a grounds have been recognized administratively by the U.S. Department of Commerce, as extending approximately forty miles offshore north of Point Chehalis (Grays Harbor), Washington. However, it is likely that Willamette fish have very minor impacts (a fraction of one percent) in the tribes' ocean fisheries, because they typically return through the area early, before the tribal fisheries begin.

Lower Columbia and Willamette: Willamette River salmonids spend portions of their life cycles in the Lower Columbia and Willamette Rivers, where the four mid-Columbia treaty tribes (Yakima, Warm Springs, Nez Perce, and Umatilla) claim u&a grounds. These rights have not been adjudicated in U.S. v. Oregon, due to a settlement that effectively resolved the tribes' claims above Bonneville Dam. The Yakima Tribe has conducted a treaty fishery in the Willamette for the last several years.

CHEMICAL CONTAMINANTS OF CONCERN

The primary contaminants of concern in the lower Willamette River study area are PAHs, several trace elements, and tributyltin (TBT). Elevated concentrations of these substances were detected in the sediments of all five reaches of the study area. Chlorinated pesticides and PCBs were also detected at elevated concentrations, but these substances appear to be less widespread.

To identify contaminants of concern in sediment, measured concentrations were compared with freshwater sediment guidelines. There are fewer regulatory criteria for contaminated sediments than for water, and no criteria similar to the U.S. EPA Ambient Water Quality Criteria (AWQC) are available. However, several regulatory agencies have calculated sediment effects concentrations for freshwater sediments using local or regional sediment effects data. Many of these effects concentrations were derived from synoptic sediment chemistry and sediment toxicity test results.

Environment Canada has developed freshwater sediment quality values using a weight of evidence approach using laboratory toxicity tests, benthic studies, and modeling studies from watersheds throughout North America (Smith et al. 1996). The U.S. EPA Great Lakes National Program Office (GLNPO) has developed freshwater sediment effects concentrations based on sediment bioassays using the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. Data used by GLNPO are from the Great Lakes and several other watersheds in the Midwest and South (Ingersoll et al. 1996). U.S. EPA has produced sediment criteria based on equilibrium partitioning theory, but has developed actual criteria for only a few organic compounds (U.S. EPA 1989). The Washington State Department of Ecology has developed freshwater sediment quality values based on *H. azteca* and Microtox tests from sites in the Pacific Northwest (Cubbage et al. 1997).

For this report, NOAA has chosen to use freshwater sediment quality guidelines developed by Environment Canada to screen contaminated sediments for their aquatic toxicity potential. Two assessment values, a Threshold Effect Level (TEL) and Probable Effect Level (PEL) were used. The two values define three ranges of chemical concentrations. Concentrations below the TEL are rarely associated with adverse biological effects; those between the TEL and PEL are occasionally associated with adverse biological effects; and those above the PEL are frequently associated with adverse biological effects (Smith et al. 1996).

For the polar ionic compound TBT, concentrations measured in the sediment and pore water were compared to screening level guidelines developed for Puget Sound, Washington (Weston 1996). TBT sediment guidelines for freshwater are not available. As a member of the U.S. EPA Region 10 TBT workgroup, NOAA has supported the lower sediment screening value of 1,255 µg TBT/kg organic carbon and corresponding interstitial water concentration of 0.05 µg TBT/L. These screening values are not protective of all marine organisms (they were estimated to represent 18th percentiles), but were developed to be protective of most organisms and life stages for most chronic endpoints. The screening values were developed for Superfund sites in Puget Sound.

The SI for the lower Willamette River collected 150 surface sediment samples, 37 subsurface sediment cores, and 28 sediment porewater samples. The river was divided into five sections by river mile and the SI data are discussed by river section. All samples were analyzed for trace elements, semi-volatile organic compounds, total organic carbon (TOC), and grain size. Sixty-one surface sediment samples were analyzed for PCBs, pesticides, and organotins. Three sediment samples were analyzed for dioxins/furans and seven for chlorinated herbicides (Weston 1998). This report evaluates the surface sediment and porewater data expected to be within the biotic zone of aquatic organisms.

Habitat Exposure Characterization

Reach A

Reach A is the segment of the study area farthest downstream extending from river 3.5 to mile 5.0 with four identified sites on the river shore (Figure 1 and Table 1). PAHs were the most widespread contaminant observed at elevated concentrations, with nearly all PAHs exceeding their respective TELs and PELs (fluoranthene, pyrene, chrysene, phenanthrene, benzo(a)anthracene, and benzo(a)pyrene). Eleven individual PAHs had maximums exceeding 25 mg/kg (Table 2). The highest PAH concentrations were observed in sediments at station SD032 in a Terminal 4-Port of Portland waterway. That station contained 16 of the maximum PAH concentrations detected in the reach. Two other stations in the waterway (SD033 and SD031) also contained highly elevated concentrations of PAHs (individual PAHs exceeded 1.0 mg/kg, which is an order of magnitude higher than both TELs and PELs). Concentrations of several PAHs in samples collected near the Time Oil-Northwest Terminal and the Linnton Oil Fire Training Grounds exceeded 1 mg/kg.

Trace elements were not as elevated relative to screening guidelines as the PAHs in Reach A. Maximum concentrations of seven trace elements exceeded their respective TELs and PELs for lead at three stations and zinc at two stations. In general, concentrations only slightly exceeded the TEL. The highest concentrations of lead and zinc (and the only exceedances of PELs) were in the Terminal 4-Port of Portland (SD032 and SD033) waterway, the same area with high PAH contamination. In addition, lead and zinc exceeded their respective PELs at Station SD023 in a waterway further downstream. Zinc exceeded its PEL slightly while lead exceeded its PEL by a factor of nearly 3.

TBT was observed in the sediments above screening guidelines in six of eight samples analyzed for the substance. The detections above guidelines appeared to be spread throughout the waterway without a clear association to any of the identified sites. Reach A had the highest TBT levels observed in the study area.

Reach B

Reach B extends from River mile 5.0 to 6.0, with three sites identified on the river shore (Figure 1 and Table 1). PAHs exceeded their respective TEL concentrations in sediment at all stations measured in Reach B, and many PAHs also exceeded their PEL (Table 2). Maximum concentrations of phenanthrene, fluoranthene, and pyrene exceeded 10 mg/kg and numerous others exceeded 1.0 mg/kg. Phenanthrene exceeded its PEL at six stations. Four stations were located across the channel from the two identified sites, with three of those located upstream of Mobil Terminal. The most PAH-contaminated sediment station in Reach B, station SD041, was located on the western shore of the river between the Arco and Mobil terminals. The second most PAH-contaminated station was station SD056 with all PAHs exceeding their respective PEL. This station is located at about

Rm 6 near the eastern shore of the river, not associated with either identified site. At the remaining stations, PAHs were moderately elevated above PELs.

The trace elements were not as elevated relative to screening guidelines as the trace elements in Reach A, but maximum concentrations of six elements exceeded their respective TEL concentrations. A PEL was exceeded in only one sediment sample—lead was observed at 122 mg/kg in the same area as the high PAH concentrations on the eastern shore of the river.

TBT was observed in the sediments above screening guidelines in five of six samples analyzed for the substance. Four of the five stations where TBT concentrations exceeded guidelines were collected on the eastern shore of the river. The highest concentration of TBT (4272.0 µg/kg OC) was co-located with the highest concentrations of PAHs. Similar to the PAHs, sample locations with the highest concentrations were not in the vicinity of the identified sites in Reach B.

Reach C

Reach C extends from Rm 6 to Rm 7 with three sites identified on the river shore (Figure 1 and Table 1). The highest concentrations of PAHs in the entire study area were found in Reach C with five individual compounds exceeding 100 mg/kg (Table 2). Most detected concentrations exceeded both their respective TELs and PELs. Highly elevated concentrations of PAHs were observed in almost all sediment samples collected on the western shore of the reach. Pyrene and phenanthrene exceeded their respective PELs at 12 stations in the reach. Of the 7 stations located on the eastern shore, only 2 contained PAHs at concentrations greater than the TEL. The eastern side of the river in Reach C has fewer industries.

Similar to Reach B, the maximum concentrations of six trace elements slightly exceeded their respective TELs. Detection limits for arsenic were above the TEL. Only one detection of nickel exceeded its PEL on the west side of the river.

Tributyltin was observed in the sediments above screening guidelines in 10 of 13 samples analyzed for the substance. Unlike the PAHs, which were highly elevated on the western shore, the highest concentrations of TBT were observed on the eastern shore not associated with any of the identified sites. TBT also exceeded screening guidelines in all samples collected near the railroad bridge on the eastern shore.

Elevated concentrations of pesticides (DDT and metabolites) were observed in sediment samples within Reach C. Concentrations of DDD in five of eight samples and DDE in three of eight samples exceeded their respective PEL (no PEL has been developed for DDT). Four of the stations with high DDD concentrations were located on the western shore of the Willamette near Rm 7. The fifth station with high DDD was located in Willamette Cove. The highest concentration of concentration of DDT (320 μg/kg) was measured in Willamette Cove. Pesticides were detected throughout the reach.

Concentrations of total PCBs exceeded the TEL in two of eight sediment samples, and four non-detect samples exceeded the TEL. No detected samples exceeded the PEL for total PCBs, however, one non-detect value did exceed the PEL.

Reach D

Reach D extends from Rm 7 to Rm 8 with six identified sites on the river shore (Figure 1 and Table 1). Contamination in Reach D was not as extensive for the contaminants of concern compared to the other reaches, despite having the greatest number of identified sites. Between 50 and 85 percent of PAH concentrations detected exceeded their respective TELs, but only concentrations of phenanthrene exceeded the PEL. This exceedance, as well as the general distribution of PAHs, was on the northeastern shore of Reach D. PAHs exceeded TELs in eight sediment stations in this region, generally clustered off the shore of the Rhone-Poulenc, Gould, and Elf Atochem facilities. On the southwestern shore of Reach D, elevated concentrations of PAHs were only detected at three stations. The highest concentrations, with several individual PAHs exceeding their respective TELs, were adjacent to the Reidel facility.

Trace element concentrations in the sediment were comparable to those observed in the other reaches. Six trace elements commonly exceeded their respective TELs, but only lead and nickel exceeded their PEL, at one sediment station on the northeastern shore of the reach.

Reach D had the highest concentrations of pesticides in the entire study area. Nearly all concentrations detected of DDD and DDE exceeded their respective PELs. DDT was also detected at concentrations substantially higher than its metabolites DDD and DDE, suggesting a more recent source for the discharge. The highest concentrations were observed near and downstream of the Rhone-Poulenc facility on the northeastern shore of the reach. This facility was known to produce and discharge agricultural chemicals. Concentrations of DDD exceeded the PEL by more than an order of magnitude, and concentrations of DDT were observed between 800 and 3,100 μg/kg near the facility.

TBT was measured in the sediments above screening guidelines in 14 of 16 samples analyzed for the substance along the eastern shore of Reach D. Unlike the PAHs, trace elements, and pesticides, all exceedances of TBT were on the eastern shore, but it should be noted that few analyses for TBT were conducted on the northeastern side of the river.

PCBs were observed in only two sediment samples, with only one concentration exceeding the TEL.

Reach E

Reach E is the upstream end of the study area extending from Rm 8 to Rm 9.5, with two identified sites on the river shore (Figure 1 and Table 1). PAHs were widespread in this reach but concentrations were not as high as those observed in Reaches A, B, and C. The highest PAH concentrations were near Swan Island and the Port of Portland Ship Repair facility. At many of the stations near the facility, concentrations of individual PAHs exceeded their respective PELs by more than an order of magnitude.

Elevated concentrations of eight trace elements were observed in Reach E, four of which exceeded their respective PELs. As with PAHs, the highest concentrations of trace elements were detected near the Port of Portland Ship Repair facility. Maximum concentrations of copper (two stations), zinc (four stations), lead (one station), and mercury (one station) exceeded their respective PELs in this area.

TBT was detected in the sediments above screening guidelines in nine of 18 samples analyzed for the substance. All but one exceedance of guidelines were observed in the vicinity of the Port of Portland Ship Repair facility. TBT in porewater was detected at concentrations above screening guidelines in two samples collected near the Port of Portland facility.

PCBs were detected in 38 percent of the samples in which they were measured. However, detection limits exceeded screening guidelines. The concentration of PCBs exceeded the TEL in 80 percent of the samples in which it was detected, and the maximum concentration exceeded the PEL by a factor of two.

Harbor Wide Trends

This section of the Preliminary Natural Resource Survey evaluates the degree and distribution of sediment contamination over the entire Portland Harbor study area. Several studies conducted in the lower Willamette River have collected nearly 300 surface sediment samples. Together, the sample coverage in these investigations provides a reasonable characterization of sediment contamination in the harbor. This evaluation uses the results of surface sediment samples from the following studies:

- Columbia River/Willamette River Sediment Quality. U.S. Army Corps of Engineers, 1994/95
- Willamette River Site Investigation. U.S. Environmental Protection Agency, 1998
- McCormick and Baxter Creosoting, Remedial Investigation, Phases I & II, 1992
- Portland Shipyard Study, 1998.

Over 290 sediment samples, collected harbor-wide, were analyzed for PAH and trace element content; 130 sediment samples were analyzed for PCBs; and 60 to 90 samples were analyzed for their concentrations of many pesticides and TBT.

Similar to the evaluation of river segments, harbor-wide surface sediment data indicate that PAHs are the contaminants of most concern to NOAA. PAHs were measured in surface sediments of the harbor at concentrations exceeding ecological screening guidelines. Some trace elements, TBT, PCBs, and pesticides are also of concern, but were detected less frequently and at lower concentrations relative to screening guidelines.

PAHs

PAHs were the most widely measured contaminants in surface sediment of the harbor. Maximum concentrations of 18 individual PAHs measured ranged from 17 mg/kg (acenaphthylene) to 2,500 mg/kg (naphthalene). Phenanthrene and five high-weight compounds (benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene) are the only PAHs for which freshwater TEL and PEL screening guidelines have been developed. These PAHs are generally representative of the total PAH distribution in the study area though. These six individual PAHs were frequently detected over the entire harbor; concentrations exceeded at least one respective TEL in 87 percent of all samples. All individual TELs were exceeded in 200 samples representing a stretch of the river from downstream of Multnomah Channel to approximately river mile 6.5, and in the Swan Island Basin. PAH Toxic Units (Σ concentration$_x$/guideline$_x$) for high-weight PAHs (Figure 2) indicate widespread contamination of harbor sediments.

The incidence of concentrations of individual PAHs that exceeded their higher, PEL benchmarks was less widespread, as expected, but still occurred in up to approximately one-third of surface sediment samples, even for just the five high weight PAHs (Figure 3). Stations with PAHs above PEL guidelines identified several "hot-spot" clusters (areas where all guidelines were exceeded) in the following areas:

- An area along the northeastern shore from Willamette Cove to the McCormick and Baxter facility, and extending out into channel;
- An entire segment of river from downstream of the St. Johns Bridge to the SP&S bridge (approximately Rm 6 to Rm 7), especially along the southwestern shore of the harbor between the GASCO and Elf Atochem;
- The three waterways on the east shore near the Port of Portland Terminal 4 Facility and the eastern portion of the river in that vicinity;
- The south shore of the harbor near the ARCO and Mobil facilities; and
- The central portion oft the river near the Time Oil Linnton Terminal.

The largest cluster of PAH-contamination was observed in river and wetland sediment adjacent to the McCormick and Baxter creosote site. PEL guidelines were exceeded at 27 sediment stations near the site with concentrations of the six individual PAHs ranging from 24 to 390 mg/kg. Screening guidelines were exceeded at stations up to 150 m offshore and 800 m downstream of the site.

Another cluster of PAH contamination with concentrations above PEL screening guidelines was on the south shore between the GASCO and Elf Atochem facilities. In this area, a line of eleven sediment stations extending for about 1 km contained the six individual PAHs at concentrations ranging from 0.89 to 140 mg/kg. The highest concentrations were measured near the GASCO facility. Concentrations of PAHs exceeding PELs were also detected at a mid-channel sediment station off of the GASCO facility. Measured concentrations ranged from 99 to 260 mg/kg at this mid-channel station.

PAH concentrations exceeded their respective PELs near two Port of Portland facilities—near Terminal 4 and the adjacent waterways on either side of this facility, and at the mouth of the Swan Island basin near Port of Portland Ship Repair. At Terminal 4, up to seven stations within the waterways contained PAHs at concentrations exceeding PELs, ranging from 0.4 to 12 mg/kg. Near the Port of Portland ship repair facility, one to five stations contained individual PAHs at levels exceeding their PELs, with maximum concentrations of 4.3 mg/kg. Up to 30 stations in the Swan Island basin contained PAHs exceeding the lower TELs.

PAHs exceeded their respective PELs at three sediment stations near the Linnton Oil Fire Training Grounds at concentrations ranging from 0.48 to 2.3 mg/kg. Similar concentrations were also observed at a mid-channel station near this area.

Average PAH concentrations in the Portland Harbor Study Area are up to two orders of magnitude higher than in areas immediately upstream and downstream of the harbor. For example, the average phenanthrene concentration in 210 sediment samples (excluding the McCormick and Baxter site data) in the harbor was 4,328 parts per billion (ppb) compared to an average of 73 ppb from 12 stations just outside the study area. Average PAH concentrations in Portland Harbor (excluding the McCormick and Baxter data) range from 1.6 (fluoranthene) to eight times (phenanthrene) their respective PEL concentrations. Individual PAHs in areas just upstream and downstream of the harbor area are typically only twice their lower TEL guideline values.

Trace Elements

Trace-element contamination was less widespread in sediments than PAH contamination. Trace elements, such as zinc (Figure 4) did not exceed screening guidelines in distinct clusters in the harbor, except for areas near Swan Island. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc exceeded their respective TEL in 5 to 91 percent of sediment samples collected. Copper and nickel exceeded their respective TEL the most frequently (75 and 91 percent of samples), followed by chromium (35 percent) and zinc (43 percent). Other trace elements exceeded their respective TELs in less than 25 percent of samples.

Concentrations of six trace elements exceeded their respective PELs in less than eight percent of samples collected. Zinc exceeded its PEL at 17 stations, with 13 located in the Swan Island basin, two located in the waterways near Terminal 4, and 2 located near the McCormick and Baxter site. Copper exceeded its PEL at 9 stations and nickel at 2 stations near Swan Island. Trace element concentrations rarely exceeded their corresponding PEL outside of the Swan Island basin.

Tributyltin

TBT was analyzed only in 61 surface sediment samples harbor-wide, but was detected in 90 percent of those samples. The screening guideline of 1255 μg/kg OC was exceeded in 56 percent of samples. A cluster of 8 sediment stations where TBT concentrations exceeded screening guidelines was observed in the Swan Island basin near the Port of Portland Ship Repair facility. Screening guidelines were exceeded at stations spread through most of the northern shore of the harbor; with fewer exceedances on the southern shore.

PCBs

Detectable concentrations of total PCBs in surface sediment of the harbor were clustered near the mouth of the Swan Island basin (Figure 5). Concentrations of PCBs exceeded the TEL at 17 stations and the PEL at 4 stations near Swan Island (300-394 μg/kg). In addition, PCB concentrations exceeded the PEL at three stations in source areas on Swan Island (284-2,600 μg/kg). The TEL was exceeded at only seven other stations spread throughout the rest of the harbor. PCB detection limits were higher than the TEL at most stations where non-detects were reported and thus provided censored information for most of the harbor. Combined data sets do indicate that concentrations in the navigation channel are below the TEL. PCBs appeared to be elevated upriver from the study are too.

Pesticides

DDT and its metabolites DDE and DDD were the pesticides most frequently detected in the harbor (Figure 6). All three were measured at elevated concentrations clustered near Doane Lake; DDE and DDD exceeded their respective PELs (guidelines are not available for DDT). The PEL for DDD was exceeded at 17 stations with concentrations ranging from 22 to 460 μg/kg. The PEL for DDE was exceeded only at five stations; however, the detection limits for DDE exceeded the PEL at 11 other area stations where non-detects were reported. Elevated concentrations of DDT were also measured in the area, and DDT was a large proportion of total DDT, suggesting a more recent release (Figure 6). DDT was measured at 14 stations at concentrations ranging from 76 to 3,100 μg/kg, which is one to two orders of magnitude above the TEL for total DDTs (six isomers; 7 μg/kg). As discussed in the evaluation of river segments, the Rhone Poulenc facility, the site of pesticide manufacturing, is located on Doane Lake adjacent to harbor contamination. Beyond the Doane Lake area, concentrations of DDE and DDD infrequently exceeded their respective TELs in the harbor.

EFFECTS ON HABITATS AND SPECIES

Sediment contamination by PAHs, trace elements, and TBT in the lower Willamette River can cause adverse effects to biota occupying several trophic levels. All of these substances are persistent in aquatic systems and are toxic to aquatic organisms at low to moderate concentrations. PAHs are known to cause adverse reproductive effects, mutagenesis, teratogenesis, and cancer in fish (Eisler 1987). TBT has been described as the most toxic substance ever deliberately introduced into natural waters (Weston 1996).

Measured Impacts

Bioassessment studies within the study area have been conducted in association with the McCormick and Baxter NPL site located at Rm 7 within Reach D. Bioassays using the freshwater amphipod *H. azteca* and the Microtox test showed significant adverse effects with sediments collected from the nearshore environment adjacent to the McCormick and Baxter study site (PTI 1992).

Bioaccumulation studies using the edible muscle tissue of crayfish and largescale sucker showed concentrations of naphthalene, acenaphthene, and fluorene between 18 and 60 μg/kg. PAHs are rapidly metabolized in aquatic organisms, and detectable quantities are rarely found in tissue sample analyses. Hence, these data provide evidence for ongoing uptake of PAHs potentially associated with the McCormick and Baxter site (PTI 1992).

Liver tissues of 249 largescale suckers collected near the McCormick and Baxter site were examined for histopathological abnormalities. The most commonly observed abnormality (found in 66 percent of fish) was the presence of mononuclear cell infiltrates, an indication of mild liver inflammation. However, there were no statistical differences between the prevalence of this condition in pooled stations near the site and reference. There was no evidence of more serious injury (e.g., neoplasia or megalocytic hepatosis) in any of the fish livers examined (PTI 1992)

Predicted Impacts

NOAA estimates potential contamination to its trust resources and supporting habitat in the lower Willamette River by comparing the concentrations of those contaminants in sediment with the concentrations of those substances shown in other studies to be toxic to aquatic organisms. These estimates are preliminary for several reasons.

First, there is little comprehensive information regarding the areal and temporal distribution of contaminants. Because of this limited information, the maximum concentrations observed in the relevant media in the habitats of interest to NOAA are used for comparisons in this document.

concentrations observed in the relevant media in the habitats of interest to NOAA are used for comparisons in this document.

Second, there is little information about the toxicity of site-related substances to the aquatic species of interest to NOAA. For this document, toxicity estimates are based primarily on aggregate toxicity analyses that provide a basis for estimating the potential for overall impacts to the ecosystem. Specifically, chemical concentrations in the sediments are compared to available screening guidelines. It is recognized that the sediment screening guidelines used may not be the most appropriate for the specific habitats of the lower Willamette River because of site- and habitat-specific factors. However, these metrics do provide effects-based concentrations that should be reasonably protective of NOAA's trust resources from direct toxic effects, as well as from indirect injury resulting from a reduction in prey base or habitat quality.

Finally, little is known about the effects of exposure to the combination of substances that may be in the study area. In addition, it is not unlikely that other, unmeasured substances are present and contributing to the overall toxicity of the releases. The few studies that have been performed indicate that effects of multiple contaminants are more likely additive than either synergistic or antagonistic. As a result, the simple comparisons presented above may underestimate the actual threat posed by the releases. Below is a summary of the environmental behavior and toxic effects of some of the more prevalent contaminants of concern observed in the Lower Willamette River.

PAHs

PAHs are a group of hydrocarbon compounds composed of two or more fused benzene rings, which may have substituted groups attached to one or more rings. In general, toxicity increases as molecular weight increases and with increasing alkyl substitution on the ring. The higher molecular weight PAHs (four- to seven-ring aromatics) are known carcinogens or co-carcinogens. Other toxic effects associated with PAHs include cytotoxic, mutagenic, and reproductive effects. PAHs are relatively immobile in aquatic media with a strong tendency to accumulate in organically enriched sediments. The bioavailability of PAHs entrained in sediments is less than PAHs in solution, so they are generally less toxic. However, effects of PAHs in the sediments have been documented in aquatic organisms (Eisler 1987).

Data on the toxicity of PAHs entrained in freshwater sediments are limited, but some exposure data are available to compare with site conditions. In studies of heavily polluted areas, high mortality in sediment bioassays using the amphipod *H. azteca* and the midge *C. riparius* have been observed. For example, Yake (1986) found 95 percent mortality in *H. azteca* exposed to contaminated Lake Union, Washington sediment containing individual PAHs ranging from 40 mg/kg (fluorene and naphthalene) to 510 mg/kg (fluoranthene). Pope (1993) found 100 percent mortality with the mayfly *Hexagenia limbata*, *C. riparius*, and *H. azteca* at total PAH concentrations ranging from 685 to 1,154 mg/kg. These concentrations are substantially above the threshold for adverse effects, but are near the level of contamination observed in the most contaminated samples in the lower Willamette River.

In a study of sediment toxicity in Waukegan Harbor, Illinois, Ingersoll and Nelson (1990) found statistically significant toxicity to *H. azteca* and *C. riparius* exposed to sediments contaminated with PAHs at the following concentrations: 120 µg/kg naphthalene; 1,100 µg/kg phenanthrene; 220 µg/kg anthracene; 1,000 µg/kg fluoranthene; 950 µg/kg pyrene; 490 µg/kg benzo(a)anthracene; 620 µg/kg chrysene; 460 µg/kg benzo(a)pyrene; and 300 µg/kg indeno (1,2,3-c,d)perylene. Concentrations of PAHs observed in the sediments of Reaches A, B, and C of the Willamette River study area consistently exceeded these levels.

Although PAHs are rapidly metabolized by many fish species, biological effects associated with high tissue burdens of PAHs have been documented in contaminated areas. The frequencies of external and grossly visible liver tumors were high in brown bullhead (*Ictalurus nebulosus*) collected from the Black River, Ohio. Tumor frequency occurred between 28 and 44 percent of age 4 fish compared to none found at a clean reference lake. Tissue concentrations associated with these effects ranged from 46 to 130 µg/kg naphthalene; 1,200-3,100 µg/kg phenanthrene, 780-1,200 µg/kg fluoranthene; 420-850 µg/kg pyrene; <10-16µg/kg benzo(a)anthracene; and 6.4-19 µg/kg benzo(a)pyrene (wet weight). The concentrations of individual PAHs in the sediments were reportedly between 10 and 100 mg/kg (Baumann et al. 1987). Concentrations of PAHs observed in the sediments of Reaches A, B, and C are within these ranges.

Juvenile chinook salmon from a contaminated urban estuary in Puget Sound, exposed to PCBs and PAHs, showed evidence of immunosuppression (Arkoosh et al. 1991). Immunosuppressed fish may be more susceptible to disease and ultimately experience increased mortality. Juvenile salmon from the contaminated estuary in Puget Sound, challenged with the marine pathogen *Vibrio anguillarum*, exhibited higher cumulative mortality after exposure to the pathogen than salmon from hatcheries or a non-urbanized estuary (Arkoosh et al. 1998). Factors that affect health in the early life stages may affect recruitment to adults. Therefore, mortality during estuarine and early life stages of juvenile salmon from increased disease susceptibility induced by immunotoxic compounds may be a factor in year-class strength for populations with polluted estuaries (Arkoosh et al. 1998).

No severe effects were noted in largescale sucker studies conducted near the McCormick and Baxter site in Reach D (reported above). However, PAH contamination in this reach was not as high as that found in Reaches A, B, or C. Adverse effects to fish from PAHs in the study area are possible.

Trace Elements

Trace elements are persistent contaminants that tend to sorb to particulates and sediments, are toxic at relatively low concentrations, and can bioaccumulate in aquatic organisms (Clement Associates 1985). Many trace elements are important in plant and animal nutrition, where, as micronutrients, they play an essential role in tissue metabolism and growth. Of those detected in site-related media, chromium, copper, and zinc are considered essential micronutrients. However, exposure to elevated concentrations of these substances can result in poor health, retarded growth, and death. The trace elements cadmium, lead, and mercury have no micronutrient value and are highly toxic to aquatic organisms. The embryonic and larval stages of aquatic animals are generally the most sensitive life stages to the toxic effects of trace elements.

Data on the toxicity of trace elements entrained in freshwater sediments are limited, but some exposure data are available to compare with site conditions. In sediment toxicity tests conducted on the Saginaw River, Michigan, mortality and sublethal effects to growth and reproduction were observed with *H. azteca* and *C. riparius* exposed to the following concentrations of trace elements: 3.6 mg/kg arsenic; 10 mg/kg cadmium; 319 mg/kg chromium; 187 mg/kg copper; 86 mg/kg lead; 0.3 mg/kg mercury; 157 mg/kg nickel; and 381 mg/kg zinc. Total PCBs were also observed in this sample at a concentration of 8.3 mg/kg. In addition, several PAHs were observed at concentrations between 100 and 500 µg/kg (Ingersoll et al. 1992). This suite of inorganic and organic substances and the concentrations observed are similar to those observed in the lower Willamette River.

In sediment tests conducted on the Clark Fork River, Montana within the influence of mining operations and no organic contamination, adverse biological effects were observed at higher concentrations of trace elements. Significant acute, growth, and reproductive effects were observed in *H. azteca*, *C. riparius*, and rainbow trout (*Oncorhynchus mykiss*) when exposed to sediments containing the following concentrations of trace elements: 404 mg/kg arsenic, 41.1 mg/kg cadmium; 7,820 mg/kg copper; 679 mg/kg lead; 4.54 mg/kg mercury; 15.7 mg/kg nickel; and 10,100 mg/kg zinc (Kemble et al. 1994). These concentrations are generally higher than those observed in the lower Willamette River.

Also in the Clark Fork River, a range of trace element concentrations were associated with sublethal effects to *H. azteca* growth but not to mortality. Sublethal effects to growth were observed within the following ranges: 25.6-56.5 mg/kg arsenic; 2.4-13.3 mg/kg cadmium; 31.6-39.3 mg/kg chromium; 255-878 mg/kg copper; 63.2-99 mg/kg lead; 0.043-0.81 mg/kg mercury; 14-23.8 mg/kg nickel; and 625-4,200 mg/kg zinc. Organic compounds were generally undetected in these samples. These trace element concentrations produced no significant impacts to exposed rainbow trout (*O. mykiss*; Kemble et al. 1994).

Many of the trace elements detected in the sediments of the lower Willamette River fall within the ranges where sublethal effects on invertebrates have been observed.

TBT

Organotin compounds such as TBT are most commonly used as pesticides in commercial and agricultural applications. The toxicity of an organotin compound increases with progressive introduction of organic groups at the tin atom (Fent 1996). TBT, with its three butyl groups, is highly toxic, which led to its use as a fungicide, bactericide, and algaecide, particularly in antifouling paints. TBT leaching from ship hulls, and releases of fugitive paint and paint chips from vessel repair and dry dock facilities, appear to be major pathways into the aquatic environment (Fent 1996; Uhler et al. 1993).

After release into surface waters, TBT is likely to partition to suspended particles in the water column and sediments; up to 99 percent of the TBT may reside in the sediments (Huggett et al. 1986). Concentrations in sediment can be one to several thousand times higher than concentrations found in the overlying water (Bryan and Gibbs 1991). TBT has significant lipid solubility and thus a high potential for bioaccumulation in aquatic organisms. Fish, crustaceans, and bivalves can bioconcentrate TBT to concentrations that are orders of magnitude higher than the exposure concentration (Clark et al. 1988). Oysters are known to bioaccumulate TBT in their tissues at concentrations from 2,300 to 16,000 times higher than is found in the water (Wade et al. 1988; Bryan and Gibbs 1991).

Studies have demonstrated that TBT is deleterious at concentrations far lower than those indicated for other pollutants (Clark et al. 1988). In freshwater ecosystems, much less is known than in marine systems about which species are highly susceptible. In a freshwater snail, egg laying was reduced at TBT concentrations as low as 1 ng/L. Early life stages of European minnow were found to develop histologic alterations at 0.8 µg/L and rainbow trout yolk sac fry showed growth retardation after long-term exposure to TBT concentrations of 0.2 µg/L (Fent and Hunn 1995). TBT concentrations in pore water samples from the Willamette River study area are higher, in some areas, than those shown to cause chronic effects in other studies.

Few studies have evaluated the effects of sediment-entrained TBT to freshwater organisms. However, benthic studies have shown that freshwater bivalve populations can be completely eliminated when bulk sediment TBT concentrations exceed 800 µg/kg (Fent and Hunn 1995). Most of the TBT concentrations in the Willamette River study area were below this level, but some were within the same magnitude and a few exceeded this concentration.

DDT, DDE, DDD

DDT is a broad-spectrum organochlorine pesticide that was widely used until January 1973, when the U.S. EPA canceled all uses of the substances in the United States. Low vapor pressure, high lipid solubility and resistance to degradation and photo-oxidation make the substance both highly persistent in environmental media and a strong biomagnifier in aquatic and terrestrial food chains. Due to its extremely low solubility, DDT is strongly retained by soils and sediments. The breakdown products of DDT, primarily DDD and DDE, are similar in stability. DDT is highly toxic to aquatic organisms (generally at concentrations less than 50 μg/L) with invertebrates showing a greater sensitivity than fish. Reproductive impacts such as lower egg hatchability, fry survival, and abnormalities in fish have also been documented (Pesticide Information Profiles 1996).

Very few freshwater sediment studies have specifically evaluated the toxicity of DDT, DDE and DDD. In most studies, these substances have been co-contaminants with other pollutants such as PCBs or PAHs; therefore, it is not known to what extent the pesticides have contributed to the observed effects. Acute (survival) and chronic (growth) toxicity was observed when *H. azteca* was exposed to contaminated sediments from Waukegan Harbor. Concentrations of DDE in the Waukegan study ranged from 13 to 98 μg/kg in sediment. Concentrations of DDT ranged from 1 to 63 μg/kg while DDD ranged from 11 to 22 μg/kg. Concentrations of several PAHs exceeded 1.0 mg/kg and total PCBs ranged from 0.9 to 8.9 mg/kg in these sediments as well (Kemble 1998). In the Sheboygan River, *C. tentans* and *H. azteca* exposed to contaminated sediments experienced 100 percent mortality at concentrations of 710 μg/kg of DDE and 240 μg/kg of DDT. It should be noted that very high concentrations of PCBs (758 mg/kg) were also observed in the Sheboygan River sediments (NOAA 1998).

Concentrations of DDT, DDE and DDD in the sediments of Reach D near the Rhone-Poulenc agricultural pesticide facility far exceeded concentrations observed where toxic responses have been noted in other studies.

REFERENCES

Arkoosh, M. R., Casillas, E., McCain, B., and U. Varanasi. 1991. Suppression of immunological memory in juvenile chinook salmon (*Oncorhynchus tshawytscha*) from an urban estuary. *Fish and Shellfish Immunology* 1:261-277.

Arkoosh, M. R., Casillas, E., Huffman, P., Clemons, E., Evered, J., Stein, J. E., and U. Varanasi. 1998. Increased susceptibility of juvenile chinook salmon from a contaminated estuary to *Vibrio anguillarum*. *Trans. Am. Fish. Soc. 127*:360-374.

Baumann, P.C., W. D. Smith, and W.K. Parland. 1987. Tumor frequencies and contaminant concentrations in brown bullheads from an industrialized river and a recreational lake. *Transactions of the American Fisheries Society 116*:79-86.

Becker, C.D. 1973. Food and growth parameters of juvenile chinook salmon, *Oncorhynchus tshawytscha*, in central Columbia River. *Fishery Bulletin. 71*(2):387-400.

Bennett, D.E. and C. A. Foster. 1991. 1990 Willamette River spring chinook salmon run fisheries and passage Willamette Falls. Portland, Oregon: Oregon Department of Fish and Wildlife, Columbia River Management.

Byran, G.W. and P.E. Gibbs. 1991. Impact of low concentrations of tributyltin (TBT) on marine organisms: a review. Chapter 12. pp. 323-363. In: *Metal Ecotoxicology: Concepts and Applications*. M.C. Newman and A.W. Macintosh, (eds). Chelsea, Michigan: Lewis Publishers.

Clark, E.A., R.M. Sterritt, and J.N. Lester. 1988. The fate of tributyltin in the aquatic environment. *Environ. Sci. Technol. 22*(6):600-604.

Clement Associates. 1985. Chemical, physical, and biological properties of compounds present at hazardous waste sites. Washington, D.C.: U.S. Environmental Protection Agency.

Cubbage, J. D. Batts, and S. Breidenbach. 1997. Creation and analysis of freshwater sediment quality values in Washington state. Olympia: Washington Department of Ecology. 57p + appendices.

Eisler. R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service. *Biological Report 85*(1.11). 81pp.

Federal Register. 1998. Code of Federal Regulations Parts 222, 226, and 227 Volume 63, No. 45, Monday, March 9, 1998, Proposed Rules. Department of Commerce, National Oceanic and Atmospheric Administration. Washington, D.C.: U.S. Government Printing Office.

Fent, K. 1996. Ecotoxicology of organotin compounds. *Critical Reviews in Toxicology 26*(1):1-117.

Fent, K. and J. Hunn. 1995. Organotins in freshwater harbors and rivers: temporal distribution, annual trends, and fate. *Environ. Toxicol. Chem. 14*:1123-1132.

Foster, C., Fishery Biologist, Oregon Department of Fish and Wildlife, Clackamas, Oregon, personal communication, June 23, 1998.

Foy, M.G., K.K. English, C.R. Steward, J. Big Eagle, and C. Huntington. 1995. Sockeye salmon catch, escapement, and historical abundance data. A report prepared for U.S. Dept. Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center *In* Gustafson, R.G., Wainwright, T.C, Winans, G.A, Waknitz, F.W., Parker, L.T., and R.S. Waples. 1997. Status Review of Sockeye Salmon from Washington and Oregon. NOAA Technical Memorandum NMFS-NWFSC-33. Seattle, WA.

Howell, P., Jones, K., Scarnecchia, D., LaVoy, L., Kendra, W., and D. Ortman. 1985. Stock assessment of Columbia River anadromous salmonids; Volume I: chinook, coho, chum, and sockeye salmon stock summaries. Project No. 83-335. Portland, Oregon: Bonneville Power Administration.

Huggett, R.J., M.A. Unger, and D.A. Westbrook. 1986. Organotin concentrations in southern Chesapeake Bay. In: Proceedings, Oceans 1986 Conference, Washington DC. 23-25 September 1986. Organotin Symposium, Vol. 4:1123-1132.

Ingersoll, C.G. and M.K. Nelson. 1990. Testing sediment toxicity with *Hyalella azteca* and *Chironomus riparius*. In: W.G. Landis and W.H. van der Schalie (eds.), *Aquatic Toxicology and Risk Assessment: 13th Volume,* ASTM STP 1096. Philadelphia: American Society for Testing and Materials.

Ingersoll, C.G., W.G. Brumbaugh, A.M. Farag, T.W. La Point, and D.F. Woodward. 1992. Effects of metal-contaminated sediment, water and diet on aquatic organisms. Chicago: U.S. Environmental Protection Agency, Region 5.

Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, F.J. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. *Journal of Great Lakes Research* *22*(3):602-623.

Kemble, N.E., W.G. Brumbaugh, E.L. Brunson, F.J. Dwyer, C.G. Ingersoll, D.P. Monda, and D.F. Woodward. 1994. Toxicity of metal contaminated sediments from the upper Clark Fork River, Montana, to aquatic invertebrates and fish in laboratory exposures. *Environ. Tox. Chem.* *13*(12):1985-1998.

Kemble, N.E. 1998. Toxicity assessment of sediments from Waukegan Harbor, Illinois, 1998. Prepared by U.S. Geological Survey. Draft.

Knutsen, C. J. and D. L. Ward. 1991. Behavior of juvenile salmonids migrating through the Willamette River near Portland, Oregon. Oregon Department of Fish and Wildlife Information Report No. 91-5. Portland, Oregon: Department of Fish and Wildlife.

McCabe, G.T., W.D. Muir, R.L Emmett, and J.T. Durkin. 1983. Interrelationships between juvenile salmonids and non-salmonid fish in the Columbia River estuary. *Fishery Bulletin* *81*(4):815-826.

McCabe, G.T. and S.A. Hinton. 1996. Benthic invertebrates and sediment characteristics in freshwater beach habitats of the lower Columbia River. NOAA Technical Memorandum. Seattle: National Marine Fisheries Service/Northwest Alaska Fisheries Center.

NOAA. 1998. Sheboygan River and harbor aquatic ecological risk assessment. National Oceanic and Atmospheric Administration. Draft. Chicago: U.S. Environmental Protection Agency, Region 5.

ODFW. 1990. Willamette River subbasin salmon and steelhead production plan. Portland, Oregon: Northwest Power Planning Council and the Columbia Basin Fish and Wildlife Authority.

Pesticide Information Profiles. 1996. Extension toxicology network, pesticide information profiles. Cooperative Extension Offices of Cornell University, Oregon State University, University of Idaho, University of California Davis, and Michigan State University. Internet Web address: http://ace.orst.edu/info.extoxnet/pips/ghindex.html.

Pope, J. 1993. Analysis of benthic invertebrates from Algoma Slip core samples. Ottawa: The Ontario Ministry of the Environment and Energy, Water Resources Branch.

PTI Environmental Services. 1992. Draft remedial investigation report, Volume I. Prepared for Oregon Department of Environmental Quality, Portland, Oregon

Scott, W. B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada*. Bulletin 184. Ottawa: Fisheries Research Board of Canada.

Smith, S.L., D.D. Mac Donald, K.A. Keenleyside, C.G. Ingersoll, and L. Jay Field 1996. A preliminary evaluation of sediment quality assessment values for freshwater ecosystems. *Journal of Great Lakes Research* 22(3):624-638.

Tetra Tech. 1993. Willamette River basin water quality study. Willamette River ecological systems investigation component report. Portland, Oregon: Oregon Department of Environmental Quality.

U.S. EPA. 1989. *Briefing report EPA Science Advisory Board on the Equilibrium Partitioning Approach to generating sediment quality criteria.* EPA 440/5-89-002. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water Regulations and Standards.

United States Geological Survey (USGS). 1998. *USGS water resources of the United States real-time water database on the Internet*. Internet address: http://water.usgs.gov/public/realtime.html.

Uhler, A.D., G.S. Durell, W.G. Steinhauser, and A.M. Spellacy. 1993. Tributyltin levels in bivalve mollusks from the East and West coasts of the United States: results from the 1988-1990 National Status and Trends Mussel Watch project. *Environ. Toxicol. and Chem.* 12:139-153.

Wade, T.L., B. Garcia-Romero, and J.M. Brooks. 1988. Tributyltin contamination in bivalves from United States and coastal estuaries. *Environ. Sci. Technol.* 22:1488-1493.

Weston. 1996. Recommendations for a screening level tributyltin in Puget Sound sediment. Seattle: U. S. Environmental Protection Agency, Region 10.

Weston. 1997. Executive summary of historical sediment data, site investigation, Portland Harbor area of the Willamette River. Seattle: U. S. Environmental Protection Agency, Region 10.

Weston. 1998. Portland Harbor sediment investigation, Multnomah County, Oregon. Draft Report. Seattle: U. S. Environmental Protection Agency, Region 10.

Yake, B., D. Norton, and M. Stinson. 1986. Application of the triad approach to freshwater sediment assessment. An initial investigation of sediment quality near Gas Works Park, Lake Union. Segment No. 04-08-01 04-08-023. Olympia: Washington Department of Ecology.

Table 1. Identified sites at the Willamette River, Portland Harbor site.

Reach (river mile)	Identified Sites	Period of Operation	Reported Source Contamination	River Sediment Contamination
A (3.5 — 5)	1) Time Oil-Northwest Terminal Active petroleum bulk storage and handling facility and tank farm. Pentachlorophenol (PCP) was stored from 1967 to 1982. Documented spills occurred in 1985, 1986, 1990, and 1994. A soil removal action occurred in 1985.	1967 to present	PCP and dioxins in soils around former treatment are; Total Petroleum Hydrocarbons (TPH) in groundwater in bulk storage area	PAHs and metals
	2) Linnton Oil Fire Training Grounds Operated as a fire fighting training area.)	1951-1988	TPH, PAHs, chlorinated solvents, arsenic in soils and groundwater	PAHs and metals
	3) GATX Active bulk oil storage facility.	Since 1903	TPH and BTEX in groundwater	TPH, PAHs and metals
	4) Terminal 4-Port of Portland Active ship loading and unloading facility. Coal tar pitch, fuel, oil spills have been reported. 35,000 cubic yards of sediment removed in 1995.	Unknown	TPH, PAHs, DDT, metals	TPH, PAHs, DDE, DDD, VOCs, metals
B (5 — 6)	5) ARCO Bulk Terminal Active bulk petroleum facility.	1963 to present	TPH and PAH product layers in groundwater	PAHs and metals
	6) Mobil Oil Bulk Plant Active bulk petroleum facility. In 1985 a petroleum spill of 46,000 gallons occurred.	1928 to present	TPH in soil and groundwater; metals in groudwater	BTEX, TPH, and metals
	7) Time Oil Linnton Terminal Active bulk petroleum facility. Spills have reportedly occurred in the past. A soil removal action was conducted in 1988.	Unknown	Not reported	PAHs and metals
C (6 — 7)	8) U.S. Moorings Maintenance port for ACOE vessels. Sandblasting, scaling, repair, painting, and refueling operations take place.	1904 to present	Metals. PCBs, PAHs, DDT, dioxins, TBT	Metals, PAHs, dioxins/ furans, pesticides, and PCBs detected
	9) GASCO A former oil gasification plant, now operates as a liquid natural gas plant. All gasification wastes were discharged to the river between 1913 and 1925. Wastes were later disposed of in settling ponds.	1913 to present	PAHs and volatile aromatics	TPH, volatile aromatics and PAHs

Table 1. Identified sites at the Willamette River, Portland Harbor site.

Reach (river mile)	Identified Sites	Period of Operation	Reported Source Contamination	River Sediment Contamination
	10) Willamette Cove Various industrial uses occurred prior to current intended use as open space. These include a lumber mill, plywood mill, barrel manufacturing, and a ship building/repair facility.	1930s to 1960s	Metals, TBT, PCBs, PAHs, TCE, TPH	Metals, TBT, PCBs, PAHs, TCE, TPH
D (7 — 8)	11) McCormick and Baxter Creosoting Operated as a wood treating facility. Releases of wood-treated wastes and on-site disposal of wastes has occurred. Four outfalls are also present; one outfall discharged non-contact cooling water and three discharged stormwater runoff.	1944-1991	Metals (Cr Cu As), PCP, PAHs	Metals, PCP, PAHs
	12) Rhone-Poulenc Operated as a production facility for agricultural chemicals. On-site disposal of untreated wastes and treated process wastewater discharged to Doane Lake, which leads to the Willamette River. Free product observed in groundwater; a treatment system was installed in 1993.	1940s-1990	Chlorinated pesticides in groundwater; dioxins, metals, chorinated and aromatic solvents	Pesticides (DDT, DDE, DDD).
	13) Gould Inc. Operated a battery-processing facility at the site. Batteries were disposed of on site and into Doane Lake. Two thousand tons of lead-bearing material is piled on-site, while 80,000 tons was buried. About 6.5 million gallons of sulfuric acid was discharged to Doane Lake.	1949-1981	Metals in surface water and sediments of Doane Lake. Metals in groundwater	Lead, arsenic, chromium, and zinc
	14) Elf Atochem North America Operates as a chlorine production facility; also produces sulfuric acid, hydrogen sodium chlorate, sodium hydroxide. Six chemical spills were reported in 1986. Some soil removal actions have occurred. Four NPDES-permitted outfalls discharge to the river. On-site disposal of DDT-manufacturing wastes occurred in the 1940s and 1950s.	1941 to present	DDT in soils; Free product in groundwater.	DDT, PAHs and metals
	15 Reidel Environmental Services Operated a hazardous waste storage facility. The company operated in marine construction and dredging and specialized in marine spill cleanups. Underground storage tanks have also leaked.	1980-1984	Soils and groundwater contaminated with un-specified organic compounds, including PCBs, TPH, VOCs, PAHs	Metals and TBT detected
	16 Willbridge Bulk Fuel Area Operates as a bulk fuel storage facility.	Unknown	Product layers and	PAHs and metals

Table 1. Identified sites at the Willamette River, Portland Harbor site.

Reach (river mile)	Identified Sites	Period of Operation	Reported Source Contamination	River Sediment Contamination
	Presently used by Shell, Chevron, and Unocal.		dissolved TPH in the groundwater. Metals and DDT also found in the groundwater.	
E (8 — 9.5)	17 Port of Portland-Ship Repair An active ship repair facility with multiple dry docks. The facility has been cited for inadequate cleaning of dry docks prior to submersion and extensive discharge of sandblast grit to the river.	Unknown	PCBs, TBT, PAHs, metals	Sediment beneath drydocks contaminated with metals, TBT, and PCBs.
	18 Gunderson, Inc. Operates as a rail car manufacturing facility. Leaks from degreasing operations underground storage tanks, sandblasting, painting, and salvage yard operations have occurred.	1985 to present	Metals, solvents (TCA), and PCB	TCA, PAHs and metals

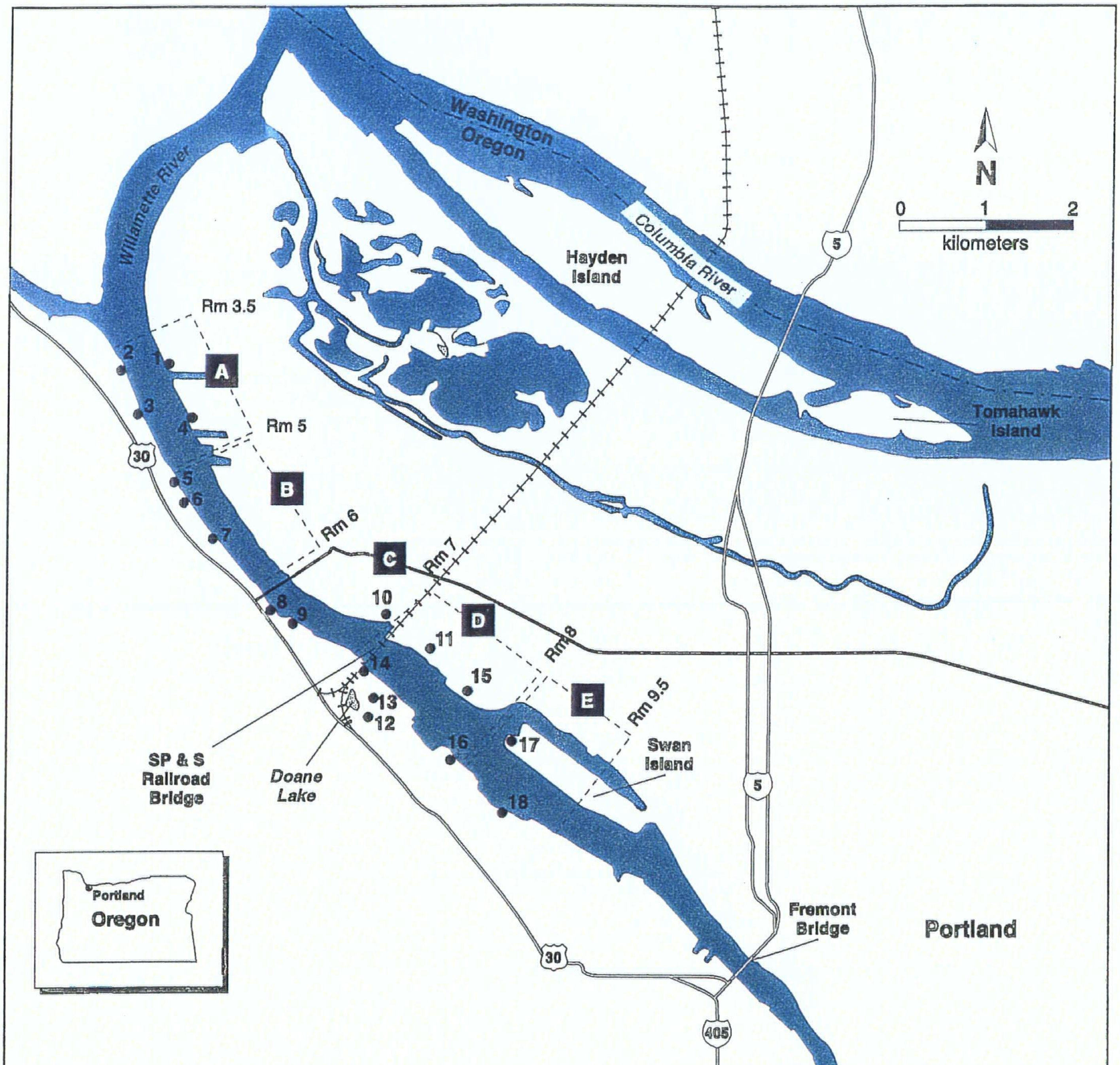
Table 2. Contaminants of concern in surface sediment from the lower Willamette River compared to ecological benchmarks.

ANALYTE	REACH A			REACH B			REACH C			REACH D			REACH E			SEDIMENT GUIDELINE	
	AVG.	MAX	%> TEL	AVG.	MAX	%> TEL	AVG.	MAX	%> TEL	AVG.	MAX	%> TEL	AVG.	MAX	%> TEL	TEL	PEL
Inorganic Substances (mg/kg)	n=35			n=20			n=21			n=42			n=32				
Aresenic	3.63	7	50.0	2.95	7	66.7	3.29	5	0.0	2.67	5	0.0	3.3	16	100.0	5.9	17
Cadmium	0.52	2.2	20.0	0.32	0.5	0.0	0.40	0.6	4.8	0.38	0.7	4.9	0.52	1	34.4	0.596	3.53
Chromium	32.7	50.7	48.6	34.81	42.5	30.0	34.43	41.7	38.1	36.14	50.6	57.1	*38.59*	67.5	50.0	37.3	90
Copper	*44.8*	77	88.6	*42.65*	71.1	75.0	*42.15*	59.1	76.2	*43.41*	85.3	78.6	*91.45*	543	93.8	35.7	196.6
Lead	29.7	262	14.3	24.3	122	10.0	21.52	36	4.8	20.21	186	4.8	26.75	110	25.0	35	91.3
Mercury	0.066	0.18	2.9	0.062	0.12	0.0	0.100	0.24	19.0	0.062	0.12	0.0	0.115	0.86	9.4	0.174	0.486
Nickel	*28.22*	34	100.0	*28.02*	31	95.0	*28.19*	37	100.0	*28.83*	38.5	97.6	*29.35*	38	100.0	18	35.9
Silver	0.57	1.2	NA	0.77	1	NA	1.14	1.7	NA	0.95	1.4	NA	0.98	1.9	NA	NA	NA
Zinc	*134.4*	373	25.7	99.8	148	10.0	121.8	185	42.9	103.2	212	11.9	*171.6*	539	40.6	123.1	314.8
Polynuclear Aromatic Hydrocarbons (µg/kg)																	
2-Methylnaphthalene	55	490	NA	81	530	NA	4091	44000	NA	12	44	NA	13	36	NA	NA	NA
Naphthalene	92	990	NA	153	1000	NA	8061	130000	NA	17	92	NA	18	110	NA	NA	NA
Acenaphthylene	24	160	NA	24	150	NA	546	3600	NA	11	29	NA	10	0	NA	NA	NA
Acenaphthene	329	7800	NA	350	5000	NA	6407	51000	NA	24	170	NA	20	130	NA	NA	NA
Fluorene	174	3500	NA	183	2100	NA	4366	22000	NA	23	160	NA	23	170	NA	NA	NA
Phenanthrene	***1597***	36000	97.1	***1230***	16000	100.0	***29,416***	170000	100.0	*124*	710	67.6	*132*	1200	63.3	41.9	514.9
Anthracene	***2597***	8900	NA	226	2700	NA	5826	26000	NA	27	110	NA	25	160	NA	NA	NA
Fluoranthene	*368*	81000	88.6	*1157*	10000	100.0	***17,000***	110000	85.7	*199*	790	52.4	*209*	1900	43.8	111.3	2354.9
Pyrene	***3415***	87000	97.1	***1199***	12000	100.0	***23,019***	140000	100.0	*211*	770	69.0	*200*	1400	68.8	53	875
Benzo(a)anthracene	***3592***	67000	100.0	*355*	2600	100.0	*7364*	72000	90.5	*81*	310	83.9	*82*	700	66.7	31.7	384.7
Chrysene	***2547***	73000	97.1	*469*	3500	100.0	*9795*	100000	85.7	*118*	340	66.7	*134*	920	56.3	57.1	861.7
Benzo(b)fluoranthene	2832	80000	NA	300	1800	NA	4583	33000	NA	80	300	NA	106	1100	NA	NA	NA
Benzo(k)fluoranthene	3156	76000	NA	329	2300	NA	3102	14000	NA	78	310	NA	83	510	NA	NA	NA
Benzo(a)pyrene	*3605*	94000	100.0	*466*	3700	100.0	*7487*	57000	90.5	*89*	400	84.8	*96*	820	68.8	31.9	782
Indeno(1,2,3-cd)pyrene	2019	50000	NA	282	2300	NA	2963	19000	NA	57	300	NA	56	430	NA	NA	NA
Dibenz(a,h)anthracene	924	25000	NA	78	560	NA	1225	9200	NA	14	74	NA	16	120	NA	NA	NA
Benzo(g,h,i)perylene	1820	44000	NA	340	3100	NA	4973	40000	NA	56	380	NA	50	290	NA	NA	NA

Table 2 cont. Contaminants of concern in surface sediment from the lower Willamette River compared to ecological benchmarks.

Analyte	Reach A			Reach B			Reach C			Reach D			Reach E			Sediment Guideline	
	Avg.	Max.	%> TEL	Avg.	Max.	%> TEL	Avg.	Max.	%> TEL	Avg.	Max.	%> TEL	Avg.	Max.	%> TEL	TEL	PEL
Organotins		n=8			n=6			n=13			n=16			n=18			
Tributyltin (µg/kg)	5260	41830	NA	129	427.2	NA	68	311.5	NA	169	320.4	NA	635	4450	NA	NA	NA
Tributyltin (µg/kg OC)	***477754***	3802727	75.0	***12335***	42720	83.3	***5817***	33495	76.9	***12550***	22886	87.5	***38179***	234211	50.0	1255*	
Pesticides (µg/kg)		n=8			n=3			n=7			n=15			n=5			
DDD	2.81	7.3	28.6	2.43	3.1	0.0	***38.26***	100	87.5	***123.2***	460	92.9	***29.8***	98	33.3	3.54	8.51
DDE	*1.54*	2.7	42.9	0.97	0	0.0	***7.64***	13	100.0	***51.3***	220	100.0	***10.6***	1.7	66.7	1.42	6.75
DDT	3.35	15	NA	4.27	7.2	NA	79.91	320	NA	676.6	3100	NA	21.1	54	NA	NA	NA
PCBs		n=8			n=3			n=9			n=12			n=13			
Total PCBs	19.4	ND	0.0	19.2	ND	0.0	*65.8*	54	100.0	***474.4***	200	50.0	*158.5*	580	80.0	34.1	277.2

NA: Guideline not available
ND: Not detected
*: Guideline for TBT is the Puget Sound screening value, normalized to organic carbon (Weston 1996).
TEL and PEL concentrations are from Smith et al. (1996)
Averages are computed with half the detection limit for below detection samples; values in italic exceed TEL; bold values exceed PEL.



A
1 Time Oil-Northwest Terminal
2 Linnton Oil Fire Training Grounds
3 GATX
4 Terminal 4-Port of Portland

B
5 ARCO Bulk Terminal
6 Mobil Oil Bulk Plant
7 Time Oil Linnton Terminal

C
8 U.S. Moorings
9 GASCO
10 Willamette Cove

D
11 McCormick and Baxter Creosoting
12 Rhone Poulenc
13 Gould Inc
14 Elf Atochem North America
15 Reidel Environmental Services
16 Willbridge Bulk Fuel Area

E
17 Port of Portland-ship Repair
18 Gunderson, Inc

Source: Prepared from NOAA Nautical Charts, Portland, 1997 and Columbia River, Saint Helens to Vancouver, 1998

Figure 1. The lower Willamette River study area, divided into river reach sections (lettered) and the individual sites (numbered) within each section.

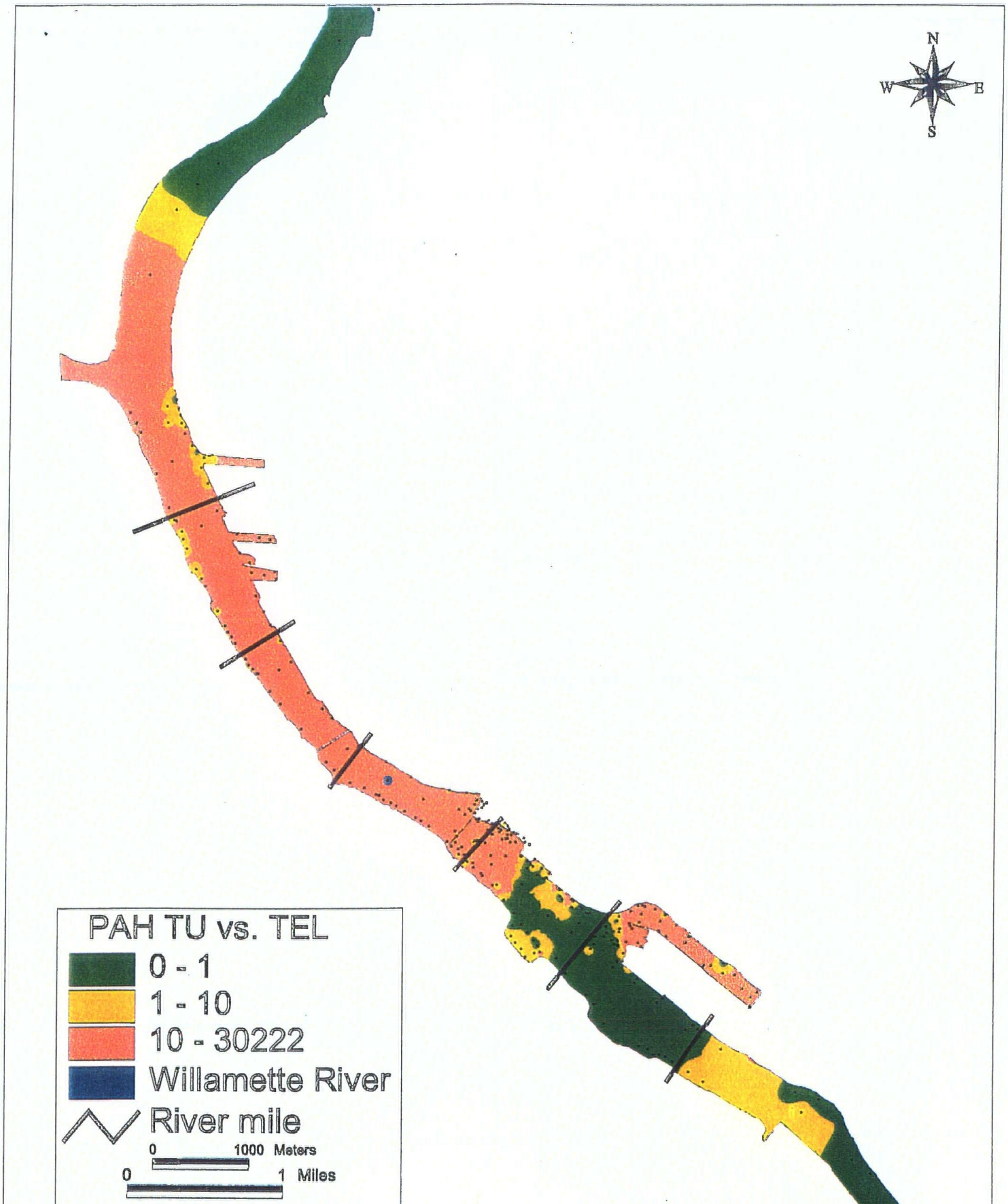


Figure 2. Contours of summed Toxic Units (TU) for five high-weight PAHs, calculated relative to their individual TEL benchmarks, as interpolated from individual sampling stations (·)

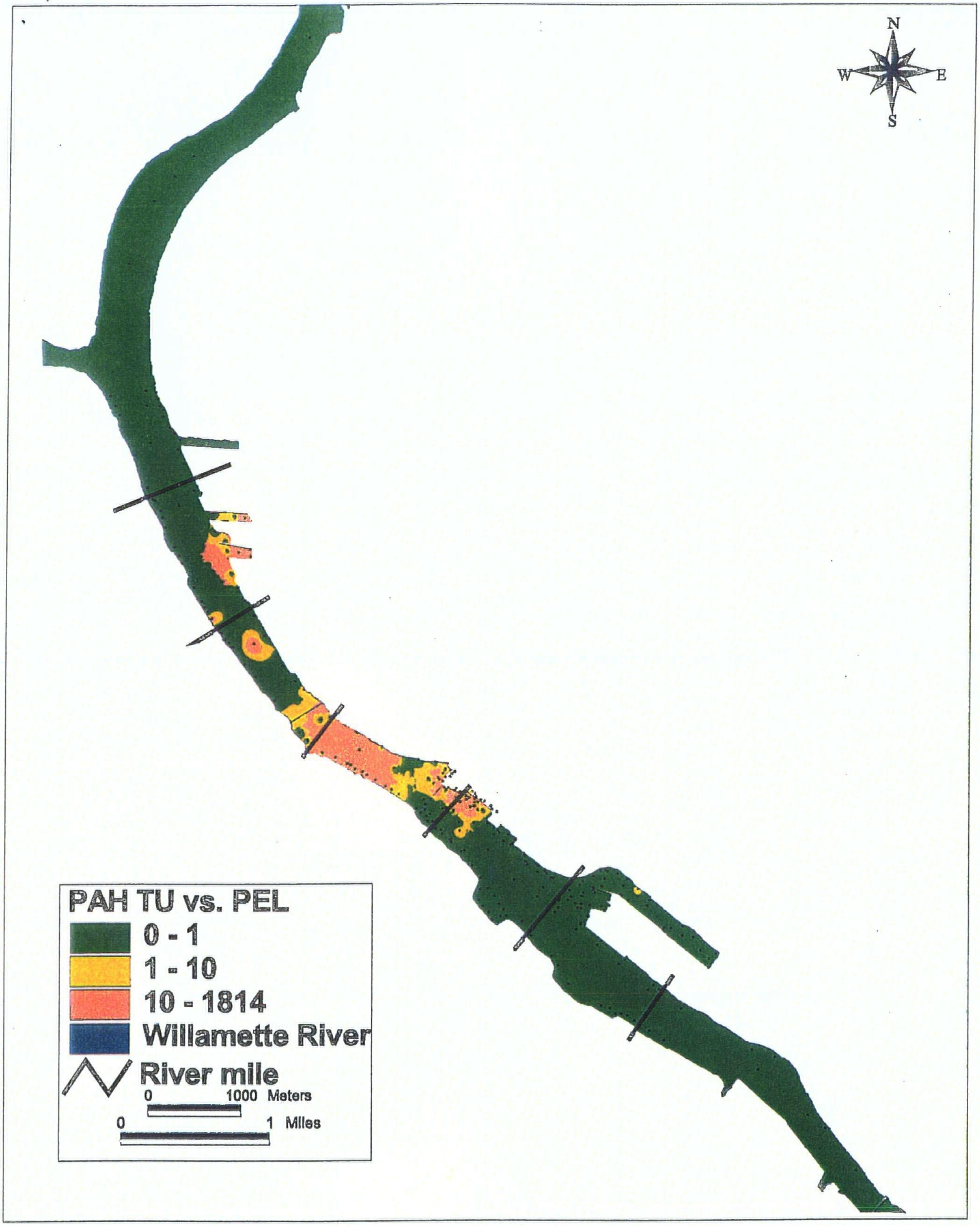


Figure 3. Contours of summed Toxic Units (TU) for five high-weight PAHs, calculated relative to their individual PEL benchmarks, as interpolated from sampling stations (·)

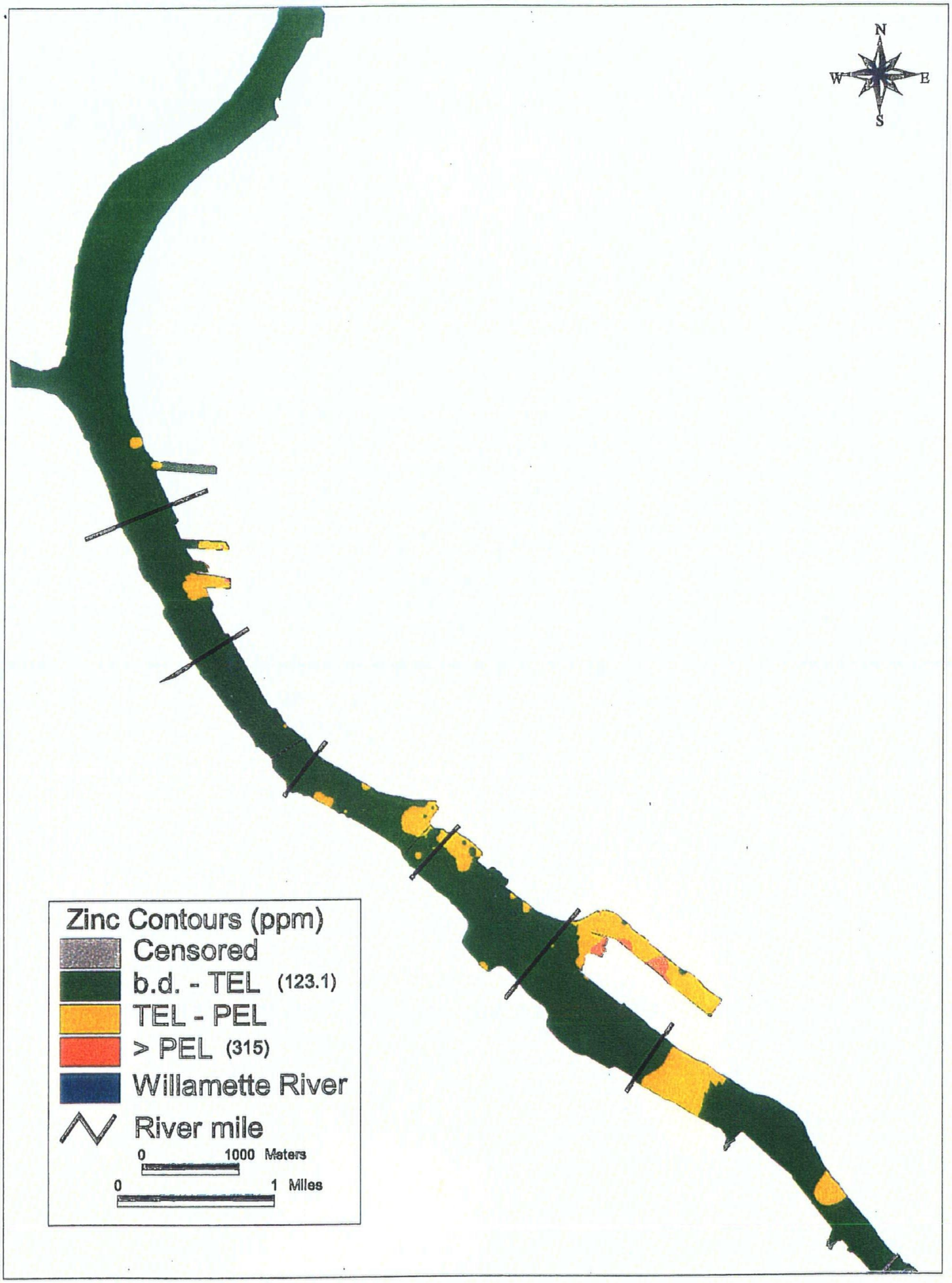


Figure 4. Contours of Zn concentrations, as interpolated from individual sampling stations (·) scaled to Zn sediment benchmarks

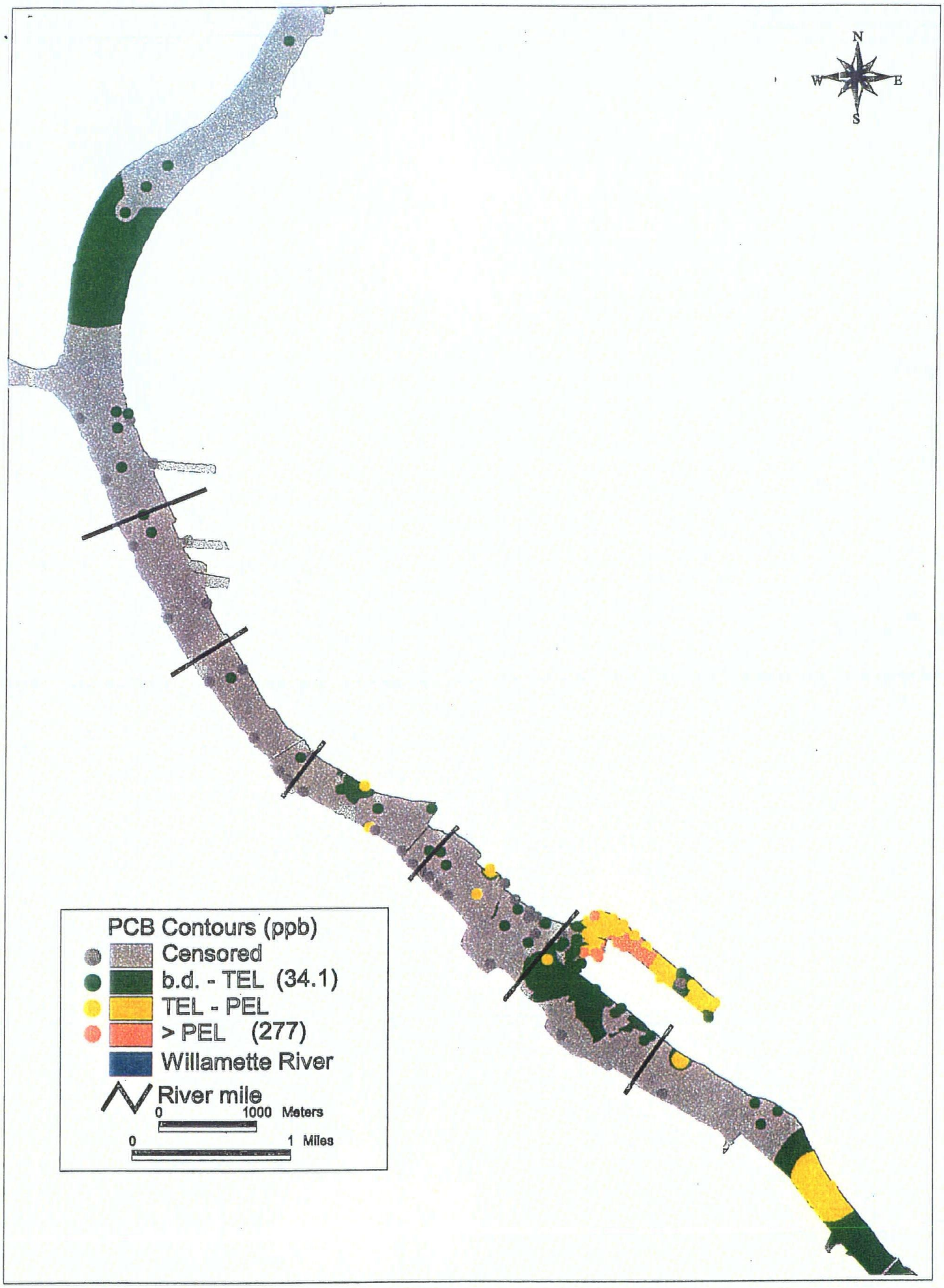


Figure 5. Contours of total PCB concentrations, as interpolated from individual sampling stations (·) with both scaled to PCB sediment benchmarks

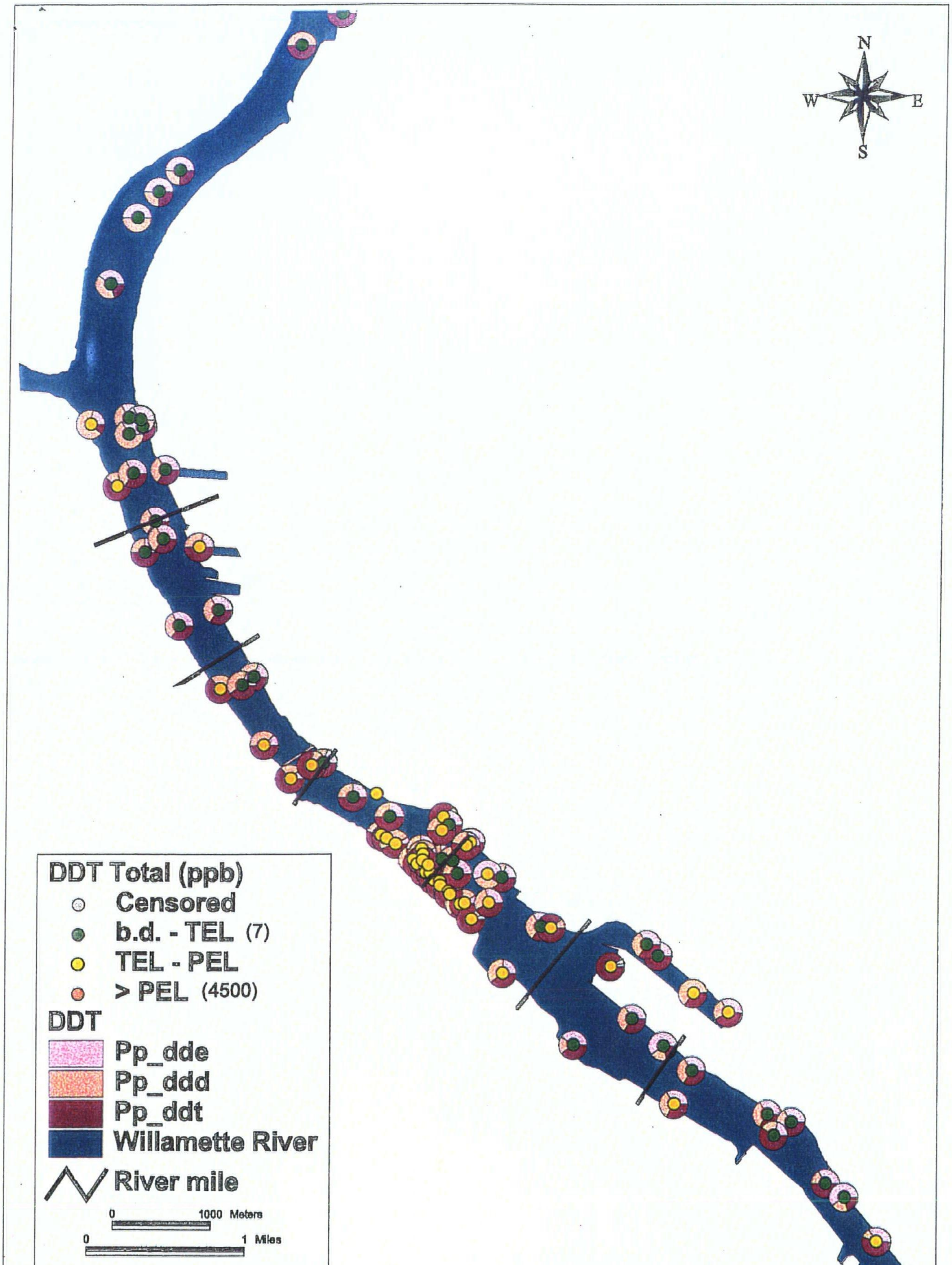


Figure 6. Relative proportions of total DDT compunds (DDT,DDD, DDE) overlayed with tDDT concentrations scaled to tDDT benchmarks

WMC

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon State Office
2600 S.E. 98th Avenue, Suite 100
Portland, Oregon 97266
(503) 231-6179 FAX: (503) 231-6195

RECEIVED
JAN 24 1996
Water Quality Division
Dept. of Environmental Quality

RECEIVED JAN 26 1996

January 19, 1996

Bruce Giles
Project Manager
Oregon Department of Environmental Quality
811 SW Sixth Avenue
Portland, OR 97204

Dear Bruce:

The U.S. Fish and Wildlife Service (Service) appreciates the opportunity to comment on the *Proposed Cleanup Plan for the McCormick and Baxter Creosoting Site, Portland, Oregon.* The plan provided an excellent, brief synopsis of the Remedial Investigation and Revised Feasibility Study for the site. The Service believes the preferred alternatives selected by the Oregon Department of Environmental Quality (DEQ) and the U.S. Environmental Protection Agency (EPA) for cleanup of soil, groundwater, and sediments will greatly reduce the potential for fish and wildlife in the area to become exposed to the numerous contaminants found at the site. However, we are concerned that the remedial actions do not sufficiently address certain contaminant issues regarding the site, and future use of the site and management of the Willamette River could influence availability of contaminants to fish and wildlife. These concerns, as well as other comments and recommendations are summarized below.

SOIL CLEANUP ALTERNATIVE

<u>Background and Concerns</u> Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were detected in six soil samples on the site during the remedial investigation at concentrations up to 380,000 parts per trillion (ppt), with a maximum Elevation Above Reference (EAR) value of 9,500. Storm water from the site was found to contain PCDDs and PCDFs up to 240 ppt in unfiltered samples, indicating the contaminants were associated with suspended particles picked up from the soil during surface flow. In addition, copper, hexavalent chromium, and zinc were present in the storm water at concentrations exceeding ambient water quality criteria established by DEQ. The Service is concerned that elevated PCDD, PCDF, and trace element concentrations from the site may be reaching the Willamette River during flood events and negatively impacting fish and wildlife at upper trophic levels. The highly toxic dioxin congener 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) has been associated with reproductive impacts on sensitive bird species at concentrations as small as 10 to 50 ppt in eggs. PCDDs and PCDFs have already been documented in the sediment and water column in the Willamette and Columbia Rivers rivers, and bald eagles nesting along the Columbia River currently exhibit egg concentrations of 2,3,7,8-TCDD ranging from 20-38 ppt fresh weight.

Although the majority of soil containing PCDDs, PCDFs, and trace elements will be removed from the site under the preferred cleanup Alternative S-5b, these contaminants may still be present in surface soil removed and treated on-site and in non-treated soil and will contaminate storm water during rain events and runoff. Releases of these contamintants from the site during flood events will likely contribute to the PCDD and PCDF loadings of the Willmette and Columbia Rivers well into the future.

Recommendation Monitoring of PCDDs, PCDFs, and trace elements in storm water from the site should continue after soil cleanup to determine if contaminants are present at concentrations potentially harmful to fish and wildlife and if additional remediation is warrented.

GROUNDWATER CLEANUP ALTERNATIVE

Background and Concerns Groundwater at the site contained high concentrations of various compounds including some trace elements (copper, chromium, zinc) and PCDDs and PCDFs. The preferred cleanup alternative for groundwater cleanup (GW-3) indicates some groundwater will be allowed to discharge into the Willamette River.

Recommendation Groundwater should be tested prior to discharge into the river. Discharges should be stopped, and additional treatment should be conducted, if contaminants are found to exceed ambient water quality criteria.

SEDIMENT CLEANUP ALTERNATIVE

Background and Concerns Sediment in the Willamette River near the McCormick and Baxter site was contaminated as much as 35 feet below surface. PCDDs and PCDFs were found in sediment up to 48,000 ppt with an EAR value of 53, and 2,3,7,8-TCDD was detected in one sample at 100 ppt. Sediment in some areas was significantly toxic to bioassay organisms. The sediment will continue to be a persistent source of contamination even though capping, as described in preferred cleanup Alternative SD-2a, will probably limit exposure of aquatic organisms to these compounds. Disruption of sediment in the area could also increase the availability of contaminants to aquatic organisms. Evidence suggests fish and crayfish in the area have accumulated dioxins and furans to a greater extent than organisms in reference areas. Bioaccumulation of dioxins and furans could also become a problem for nesting birds and other higher trophic level species along the Willamette River.

Recommendations Institutional controls should remain in place permanently after the cap is constructed. Dredging sediment or removal of woody debris should be restricted in the area of the cap and an ecological risk assessment should be conducted before either of these activities begin in order to minimize disruption of the cap or resuspension of contaminants. Access by boat within the capping zone should be restricted and the boundary of the cap (including a suitable buffer zone) should be permanently marked by buoys or a similar marking system.

FISH AND CRAYFISH ASSESSMENT

Background and Concerns: PCDDs and PCDFs were detected in muscle tissue of largescale sucker and crayfish from the Willamette River. Maximum concentrations of PCDDs and PCDFs in suckers was 5.5 ppt, and 2,3,7,8-TCDD ranged up to 2.1 ppt. These values were similar to 2,3,7,8-TCDD concentrations (<1.0 - 2.6 ppt) observed in 19 largescale sucker captured from the Columbia River by the Service. However, the Columbia River fish were analyzed as whole body samples containing 4 to 11% lipid, whereas fish from the Willamette were analyzed as muscle only (0.29 to 0.42 % lipid). Therefore, whole body burdens of PCDDs and PCDFs in suckers from the Willamette River may actually be higher than in suckers from the Columbia River, and bioaccumulation of PCDDs and PCDFs may be occurring to a greater extent in suckers sampled near the McCormick and Baxter site. Crayfish (whole body samples) collected by the Service from the Columbia River also exhibited similar body burdens (<1.0 to 1.2 ppt) of 2,3,7,8-TCDD as crayfish (muscle tissue) collected from the Willamette River, although maximum values were higher in crayfish from the Willamette River. Percent lipid was greater in samples from the Columbia, indicating actual PCDD and PCDF concentrations may be higher in crayfish from the Willamette River. The Service is concerned that the elevated concentrations of PCDDs and PCDFs in fish and crayfish sampled around the site could result in biomagnification along the food chain and impact reproduction of predators.

Recommendations: Additional sampling should occur periodically to determining concentrations of PCDDs and PCDFs in fish, crayfish, and possibly other species in the Willamette River near the McCormick and Baxter site to determine if bioaccumulation is occurring in higher trophic species over time. Whole body samples of fish and crayfish should be analyzed to better represent contaminant concentrations in fatty tissues.

HABITAT DEGRADATION

Background and Concerns: Fish and wildlife habitat has been contaminated and degraded from operations conducted at the McCormick and Baxter site. Contaminants deep in soil, sediment, and groundwater at the site will remain after cleanup and will continually release hazardous compounds into the Willamette River. Restoration of habitat on site may not be feasible due to the possibility of attracting wildlife to contaminated areas.

Recommendations: We recommend that wetland mitigation occur on-site in areas where contamination is not present in soils and where storm water containing contaminants from soil particles will not reach the wetland. Off-site mitigation should be considered if on-site mitigation is not deemed feasible. Wetland mitigation and restoration of capped areas and upland sites should be conducted using vegetation native to the Willamette valley.

SUMMARY

The Service supports the proposed cleanup alternatives selected for remediation of the McCormick and Baxter site and commends the efforts of ODEQ and EPA staff for developing a cohesive strategy for limiting the nature and extent of contamination. Unfortunately, the operations of the site in the past resulted in extensive contamination which possibly caused direct injury to fish and wildlife and reduced habitat quality on the site and nearby in the Willamette River. The proposed site cleanup plans will help to limit fish and wildlife exposure to contaminants in the future, but certain contaminants will likely continue to be released into the Willamette River from soil and water on the site and from river sediment.

To prevent further exposure to wildlife from contaminants on the site, the Service emphasizes the need for continued monitoring of surface water, groundwater, and biota around the site for residues of PCDDs, PCDFs, and trace elements. In addition, institutional controls should be maintained in the Willamette River around the area of the sediment cap, and an assessment of should be conducted prior to any activities which may disrupt the cap. The U.S. Army Corp of Engineers is currently proposing a channel deepening project which will include dredging the area of the Willamette River near the McCormick and Baxter site. This project could result in disruption of the sediment cap and release of contaminants into the river. Finally, we recommend the site be restored to its natural condition as much as possible during remediation, and vegetation native to the Willamette Valley be used in restoration activities.

We appreciate the opportunity to comment on this proposed cleanup plan. Please advise us when the final version is available. If you have any questions regarding our comments, please contact Jeremy Buck at (503) 231-6179.

Sincerely,

Carol Schuler

for Russell D. Peterson
State Supervisor

cc: Don Steffeck, Chief, Division of Environmental Contaminants
Chuck Polityka, REO, Office of Environmental Policy and Compliance

JABU\MCK&BX96

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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RECEIVED
FEB 2 1995
Waste Management & Cleanup Division
Department of Environmental Quality

January 30, 1995

Ref: 1-7-95-SP-111

Bruce Gillis
Oregon Department of Environmental Quality
811 SW Sixth Ave.
Portland, OR 97204-1390

Dear Mr. Gillis:

This is in response to your letter, dated 18 November 1994, requesting information on listed and proposed endangered and threatened species that may be present within the area of the McCormick Baxter Creosoting Site in Multnomah County. The U.S. Fish and Wildlife Service (Service) received your letter on 21 November 1994.

We have attached a list (Attachment A) of threatened and endangered species that may occur within the area of the McCormick Baxter Creosoting Site. The list fulfills the requirement of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Environmental Protection Agency (EPA) requirements under the Act are outlined in Attachment B.

The purpose of the Act is to provide a means whereby threatened and endangered species and their ecosystems on which they depend may be conserved. Under section 7(a)(1) and 7(a)(2) of the Act and pursuant to 50 CFR 402 *et seq.*, EPA is required to utilize their authorities to carry out programs which further species conservation and to determine whether projects may affect threatened and endangered species, and/or critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) which are major Federal actions significantly affecting the quality of the human environment as defined in NEPA (42 U.S.C. 4332 (2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to the Biological Assessment be prepared to determine whether they may affect listed and proposed species. Recommended contents of a Biological Assessment are described in Attachment B, as well as 50 CFR 401.12.

If EPA determines, based on the Biological Assessment or evaluation, that threatened and endangered species and/or critical habitat may be affected by the project, EPA is required to consult with the Service following the requirements of 50 CFR 402 which implement the Act.

Attachment A includes a list of candidate species under review for listing. These candidate species have no protection under the Act but are included for consideration as it is possible candidates could be listed prior to project completion. Thus, if a proposed project may affect candidate species, EPA is not required to perform a Biological Assessment or evaluation or consult with the Service. However, the Service recommends addressing potential impacts to candidate species in order to prevent future conflicts. Therefore, if early evaluation of the project indicates that it is likely to adversely impact a candidate species, EPA may wish to request technical assistance from this office.

Your interest in endangered species is appreciated. The Service encourages EPA to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact Laura Todd at (503) 231-6179. For questions regarding anadromous fish, please contact National Marine Fisheries Service, 911 N.E. 11th Ave., Room 620, Portland, Oregon (503) 230-5420. All correspondence should include the above referenced case number.

Sincerely,

Gary S. Miller
for Russell D. Peterson
State Supervisor

Attachments
SP 111
cc: PFO-ES
ODFW (nongame)
EPA

ATTACHMENT A

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OF THE PROPOSED MCCORMICK AND BAXTER CREOSOTING SITE
1-7-95-SP-111

LISTED SPECIES[1,2/]

Birds

Peregrine falcon	*Falco peregrinus*	LE
Bald eagle	*Haliaeetus leucocephalus*	LT

Fish

Snake River Chinook salmon — *Oncorhynchus tshawytscha* — (CH) **LT
Spring/summer runs in the Snake River
(petitioned June 7, 1990; proposed June 27, 1991 in 56 FR 29542-29544; listed April 22, 1992 in 57 FR 14653)

Snake River Chinook salmon — *Oncorhynchus tshawytscha* — (CH) **LT
Fall runs in the Snake River.
(petitioned June 7, 1990; proposed June 27, 1991 in 56 FR 29542-29544; listed April 22, 1992 in 57 FR 14653)

Snake River Sockeye salmon — *Oncorhynchus nerka* — (CH) **LE
Salmon River tributary to the Snake River, Idaho.
(petitioned April 2, 1990; proposed April 6, 1991 in 56 FR 14055; listed November 20, 1991 in 56 FR 58619)

Invertebrates

Great Columbia River spire snail — *Fluminicola columbianaus* — C2
Documented general location from Portland area

Plants

Howellia	*Howellia aquatalis*	LT

PROPOSED SPECIES

None

CANDIDATE SPECIES[3,4/]

Mammals

Long-eared myotis (bat)	*Myotis evotis*	C2
Yuma myotis (bat)	*Myotis yumanensis*	C2
Pacific western-big eared bat	*Plecotus townsendii townsendii*	C2

Birds

Tricolored blackbird — *Agelaius tricolor* — C2
Documented T1N, R1E, Section 5
Little willow flycatcher — *Empidonax trailli brewsteri* — C2

<u>Amphibians and Reptiles</u>		
Northwestern pond turtle	*Clemmys marmoratata marmorata*	C2
Northern red-legged frog	*Rana aurora aurora*	C2
<u>Fish</u>		
Pacific lamprey	*Lampetra tridentata*	C2
<u>Plants</u>		
Tall bugbane	*Cimicifuga elata*	C2
Howell's montia	*Montia howellii*	C2
Columbia cress	*Rorippa columbiae*	C2

(LE) - Listed Endangered *(LT) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*
(S) - Suspected *(D) - Documented*

(C1)- Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(C2)- Category 2: Taxa for which existing information indicates may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

(3A)- Category 3A: Taxa for which the Service has persuasive evidence of extinction.

(3B)- Category 3B: Names that on the basis of current taxonomic understanding do not represent taxa meeting the Act's definition of "species."

(3C)- Category 3C: Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat.

* *If a vertebrate or plant, a single asterisk indicates taxon is possibly extinct. If an invertebrate, a single asterisk indicates a lack of information for the taxon since 1963.*

** *Consultation with National Marine Fisheries Service required.*

1/ *U. S. Department of Interior, Fish and Wildlife Service, August 23, 1993, <u>Endangered and Threatened Wildlife and Plants</u>, 50 CFR 17.11 and 17.12.*

2/ *Federal Register Vol. 59, No. 134, July 14, 1994, Final Rule-Howellia aquatilis*

3/ *Federal Register Vol. 59, No. 219, November 15, 1994, Notice of Review-Animals*

4/ *Federal Register Vol. 58, No. 188, September 30, 1993, Notice of Review-Plants*

ATTACHMENT B

FEDERAL AGENCIES RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) - Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat. The process is initiated by the Federal agency after they have determined if their action may affect (adversely or beneficially) a listed species; and

3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed Critical Habitat.

SECTION 7(c) - Biological Assessment for Major Construction Projects [1/]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which are/is likely to be affected by a construc- tion project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an on- site inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or for potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within FWS, National Marine Fisheries Service, State conservation departments, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the report should be forwarded to our Portland Office.

[1/] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332.(2)c). On projects other than construction, it is suggested that a biological evaluation similar to the biological assessment be undertaken to conserve species influenced by the Endangered Species Act.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

October 30, 1995

Mr. Charles Polityka
U. S. Department of Interior
1002 NE Holladay St.
Suite 324
Portland, Oregon 97232-4181

RE: Notification to Natural Resource Trustees
McCormick and Baxter Creosoting Co. Superfund Site
Multnomah County, Oregon

Dear Mr. Polityka:

In accordance with the Superfund Amendments and Reauthorization Act of 1986, §104(b)(2), the U. S. Environmental Protection Agency (EPA) is providing notification of completion of a Remedial Investigation/ Feasibility Study (RI/FS) at the McCormick and Baxter Creosoting Company Superfund Site in Portland, Oregon. The Proposed Plan for cleanup of the site is enclosed. The Natural Resource Trustees are welcome to review and comment on the proposed remedy for the site. The full Remedial Investigation and Revised Feasibility Study reports are also available for review at the Oregon Department of Environmental Quality (DEQ), 811 SW Sixth Avenue, in Portland.

We do not anticipate entering into negotiations with Potentially Responsible Parties (PRPs) for cleanup of this site because the site owner/operator is bankrupt. If, in the future, EPA or DEQ decide to enter into settlement negotiations with any PRPs, the Natural Resource Trustees will be notified. McCormick and Baxter is a State-lead site. The cleanup of this site will be funded by the Superfund, but conducted by the DEQ. If you are interested in participating in the development of the Remedial Design and Remedial Action plans, please let me know within the next 30 days.

In addition, if you have comments on the enclosed Proposed Plan, please send any comments to DEQ directly by December 8, 1995 at the address listed in the Proposed Plan. If you have any

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questions about the RI/FS or the Proposed Plan for cleanup of the site, you may contact Bruce Gilles of Oregon DEQ at (503) 229-6662. If you have any questions about EPA involvement at this site, I can be reached at (206) 553-7216.

Sincerely,

Deborah Yamamoto

Deborah Yamamoto
Remedial Project Manager

cc: Bruce Gilles, DEQ
Jeremy Buck, USFWS
June Boynton, BIA
Chris Beaverson, NOAA

C 07 ~

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of Ocean Resources Conservation and Assessment
Hazardous Materials Response and Assessment Division
Coastal Resources Coordination Branch
7600 Sand Point Way N.E. - Bin C15700
Seattle, Washington 98115

October 26,1995

RECEIVED
OCT 30 1995
Waste Management & Cleanup Division
Department of Environmental Quality

Kathryn M. Davidson, Chief
Superfund Program Management Section
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Dear Ms. Davidson:

Enclosed please find NOAA's Preliminary Natural Resource Survey (PNRS), for the McCormick & Baxter Creosoting Company site (Site ID: P9) in Portland, Oregon to be included in the Administrative Record.

NOAA has provided information in this report concerning its position relative to a covenant not to sue for natural resource damages. This position is based on information available at the time of the survey. NOAA's position may change depending on the availability of new information.

Information on NOAA's position concerning potential natural resource damages shall remain confidential. This information is clearly marked and is contained in the section named, "SUMMARY REPORT." The summary report shall be protected under the principles of deliberative process, attorney-client, and work product. The Department of Justice or NOAA will represent NOAA's position in negotiations with responsible parties. Information contained in the section named, "FINDINGS OF FACT" is considered part of the public record.

I look forward to our continuing cooperation on Superfund site investigations.

Sincerely,

Alyce T. Fritz

Alyce T. Fritz, Ph.D.

Enclosure

cc: NOAA/ORCA - Chris Beaverson
Oregon DEQ - Bruce Gilles

NOAA PRELIMINARY NATURAL RESOURCE SURVEY

McCormick & Baxter Creosoting Company
Portland, Oregon
September, 1992

Cerclis # ORD009020603
Site ID: P9

SUMMARY REPORT

SITE CLASSIFICATION: PAST INJURY/FUTURE INJURY POTENTIAL

Injury to populations of NOAA trust resources, or their supporting habitats, within the Willamette River has occurred as a result of off-site migration of PAHs, PCP, CDDs, and CDFs from the McCormick & Baxter site . Continuing injury is expected to occur if no remedial actions are taken. Future injury can be adequately addressed as part of remedial action at the site, and significant residual injury to resources after all remedial actions are completed can be prevented.

SUBSTANTIATION OF NOAA POSITION

The McCormick & Baxter site occupies 23 hectares on the bank of the Willamette River, an important anadromous fish stream. The McCormick & Baxter Company treated wood from 1944 to 1991 using creosote, pentachlorophenol, and copper-, chomium-, and zinc-based preservatives. Soils and sub-surface soils are highly contaminated with these substances as well as with CDDs and CDFs. The groundwater beneath the site is grossly contaminated with floating and sinking product layers and dissolved phase contaminants. Four outfalls discharge runoff to the river and site-related contamination has been observed in discharges from three of these outfalls. Oily seeps have been observed on the beach adjacent to the site.

The sediments of the Willamette River adjacent to the site are contaminated with site-related organic and inorganic substances at concentrations exceeding screening concentrations. Very high concentrations have been observed in river sediment as deep as 2 m below river bottom and likely extends deeper. Sediment and pore water bioassays indicate that contaminated sediments adjacent to the site are toxic to aquatic life. Bioaccumulation studies indicate that PAHs are bioavailable and have accumulated in the edible tissues of resident biota. Histopathological studies have found evidence of mild chronic affects, but substantial impacts to resident populations have not been observed.

The Willamette River near the site serves as a migratory corridor for adult anadromous salmonids and a nursery area for outmigrating juvenile salmonids. Large recreational fisheries are present on the reach of the river in the general vicinity of the site. The Willamette River is the second largest tributary stream in the Columbia basin, which is the most prolific salmonid watershed on the West Coast. A large management effort for the continuing production of salmonids is present on the Willamette River.

ADDITIONAL INFORMATION REQUIREMENTS

Environmental investigations at the McCormick & Baxter site were comprehensive. However, before a preferred remedial alternative is selected, the results and evaluation of Phase II sub-surface sediment core data should be completed (these data were not included in the present draft of the RI/FS; they will be included in the final report). These data are necessary to determine quantitatively, the vertical extent of sediment contamination. Presently, the geographical distribution of sediment contamination at depth is based upon qualitative observations (visual contamination and odor) from sediment cores. If these data confirm the expected distribution of sub-surface sediment contamination in the Willamette River, no further investigations are necessary to characterize the site.

REMEDY AND MONITORING

The contamination observed on the site and within the Willamette River indicate that remedial efforts would have to address both sources and receptors of contamination. Sources in need of remediation are surface and subsurface soils, floating and sinking product layers in the groundwater, dissolved phase groundwater contamination, and sediments of the Willamette River. The feasibility study did not recommend a preferred alternative, but did evaluate several soil, groundwater, and river sediment remedial alternatives.

To protect NOAA trust resources in the Willamette River, sources of contamination on the site should be removed or isolated. Removal of source contamination is necessary to prevent future migration of contaminants to the Willamette River. Although wood treatment operations at the site have ceased, data indicate that the migration of contaminants from sources to the river will continue for many years without remediation. Remediation should include removal and treatment of contaminated soils, sub-surface soils, and groundwater. Remedial design should focus on the clean-up of the PAHs, PCP, dioxins, furans, arsenic, copper, chromium, and zinc.

Site-related contamination in the Willamette River is in need of remediation in order to protect NOAA trust resources. Data indicate that present sediment contamination is toxic to aquatic resources and is bioavailable; this may affect juvenile salmonids that remain in the area for extended periods. It would be necessary to remove or isolate contamination from aquatic resources, therefore capping, excavation, or a combination thereof, is recommended. If capping alternatives are preferred, the cap would have to withstand the flow regimes of normal tidal movements, yearly flood events, and 100 year floods. A comprehensive monitoring program is critical to evaluate the long term success of the cap. Monitoring would necessarily involve not only sediment chemistry, but the monitoring of bio-indicators to determine the biological availability of isolated contaminants. Monitoring should reflect ecological concerns as well as human health. Action levels, again for ecological as well as human endpoints, should be established above which the success of the cap would be re-evaluated.

CONDITIONS OF A COVENANT NOT TO SUE

A covenant not to sue could be granted depending on the selection of a remedy that adequately protects NOAA resources and restores their supporting habitat. Additional information or actions that NOAA may require are specified above. NOAA should participate in negotiations with responsible parties. NOAA may request specific compensation for damages if a covenant not to sue for past injuries to natural resources under NOAA's trust will be included as part of a settlement agreement.

NOAA CONTACTS:

Technical	Chris Beaverson	(206) 553 - 2101
Legal	Robert Taylor	(206) 526 - 6604

Oregon

DEPARTMENT OF
ENVIRONMENTAL
QUALITY

November 18, 1994

RECEIVED
NOV 21 1994
SUPERFUND REMEDIAL BRANCH

Russell Peterson
U.S. Fish and Wildlife Service
Portland Field Office
2600 S.E. 98th Ave., Suite 100
Portland, OR 97266

Re: McCormick and Baxter Creosoting Site

Dear Russell:

This letter is in follow-up to recent communication between myself and Jeremy Buck of your office concerning the need for a written request for an endangered species consultation for the McCormick and Baxter Creosoting site. Jeremy has been evaluating the RI and FS Reports and aspects of the proposed remedial action for sediments underlying the Willamette River pursuant to an interagency agreement between your office and the U.S. EPA Region 10.

DEQ is the lead agency for completion of the RI/FS and preparation of a proposed plan and final Record of Decision (ROD) for the site. Documentation of endangered or threatened species must be addressed in the ROD. DEQ is therefore formally requesting that your agency conduct the endangered species consultation requested by EPA.

Please contact me at 229-6662 to discuss the schedule for completion of the endangered species evaluation for the site.

Sincerely,

Bruce G. Gilles

Bruce Gilles, Project Manager
Site Response Section
Waste Management and Cleanup Division

BG:bg

cc: Lon Revall, WMC/DEQ
Allison Hiltner, EPA Region 10
Steve Barnett, PTI

811 SW Sixth Avenue
Portland, OR 97204-1390
(503) 229-5696
TDD (503) 229-6993

NOAA PRELIMINARY NATURAL RESOURCE SURVEY

McCormick & Baxter Creosoting Company
Portland, Oregon
September, 1992

Cerclis # ORD009020603
Site ID: P9

FINDINGS OF FACT

SITE HISTORY

The McCormick & Baxter Creosoting Company site occupies approximately 23 hectares in a highly industrialized area of Portland, Oregon on the Willamette River. The company produced treated wood from 1944 to 1991. Wood was treated in a central processing area that included four retorts. Various mixtures of creosote, pentachlorophenol, and oil were stored in a tank farm that is adjacent to the central processing area. The site also includes a 2,800,000 liter creosote tank, a creosote dock, a laboratory, several sheds, two below-ground butt tanks, a former hazardous waste disposal area, and a former waste disposal trench. Treated and untreated wood was stored in a support area which occupied the remaining property. The support area was used to prepare lumber before treatment and to store lumber after treatment; structures associated with this area include the framing shed and pole peeler (Figures 1 and 2) (PTI, 1992).

The facility pressure treated wood products with creosote, pentachlorophenol (PCP), chrome, ammoniacal copper arsenate, ammoniacal copper zinc arsenate (ACZA), and Cellon (PCP, liquid butane, and isopropyl ether). Wood was treated in the four retorts. Treated wood products removed from the retorts were allowed to cool and drip along rail lines that extend from the front door of each of the retorts. Concrete sumps are located beneath each of the retorts. Treated wood was stored at various locations over the entire property (PTI, 1992).

Between 1945 and 1971, wastewater and process cooling water were discharged directly to the Willamette River via four outfalls (Figure 2). In addition, prior to 1971, boiler water, stormwater, and oily wastes were directed or discharged to a former waste disposal trench formed by a topographically low area in the southern portion of the site. Between 1950 and 1965, waste oil containing creosote and PCP was also used to stabilize site soils. From 1968 to 1971, residues from the retorts, oil-water separators and evaporators were disposed of in the former waste disposal area. Between 1972 and 1978, wood preservative sludges were stored in metal containers and accumulated in the former waste disposal area. After 1978, sludges were shipped off-site (PTI, 1992).

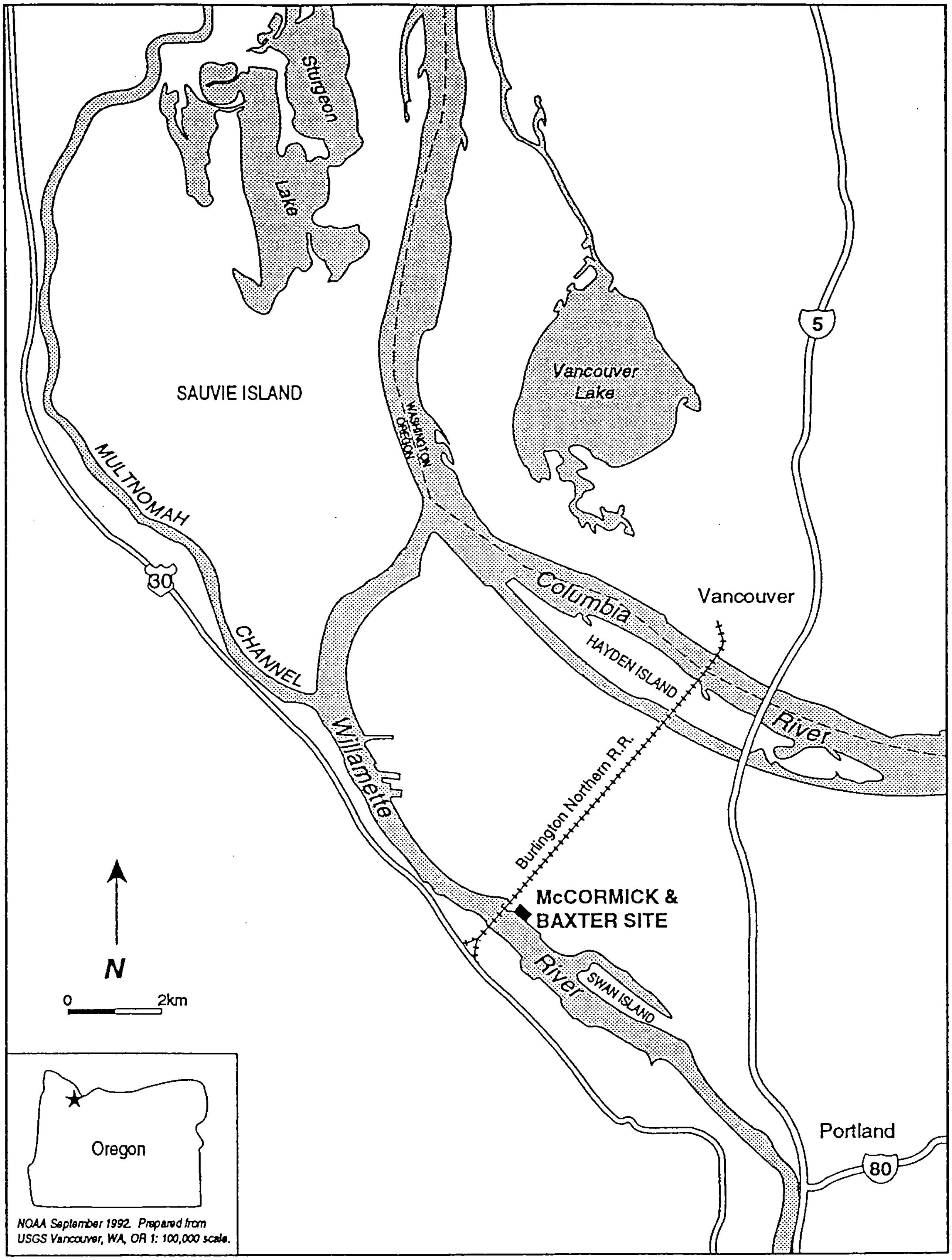

Figure 1. The McCormick & Baxter site study area near Portland, Oregon.

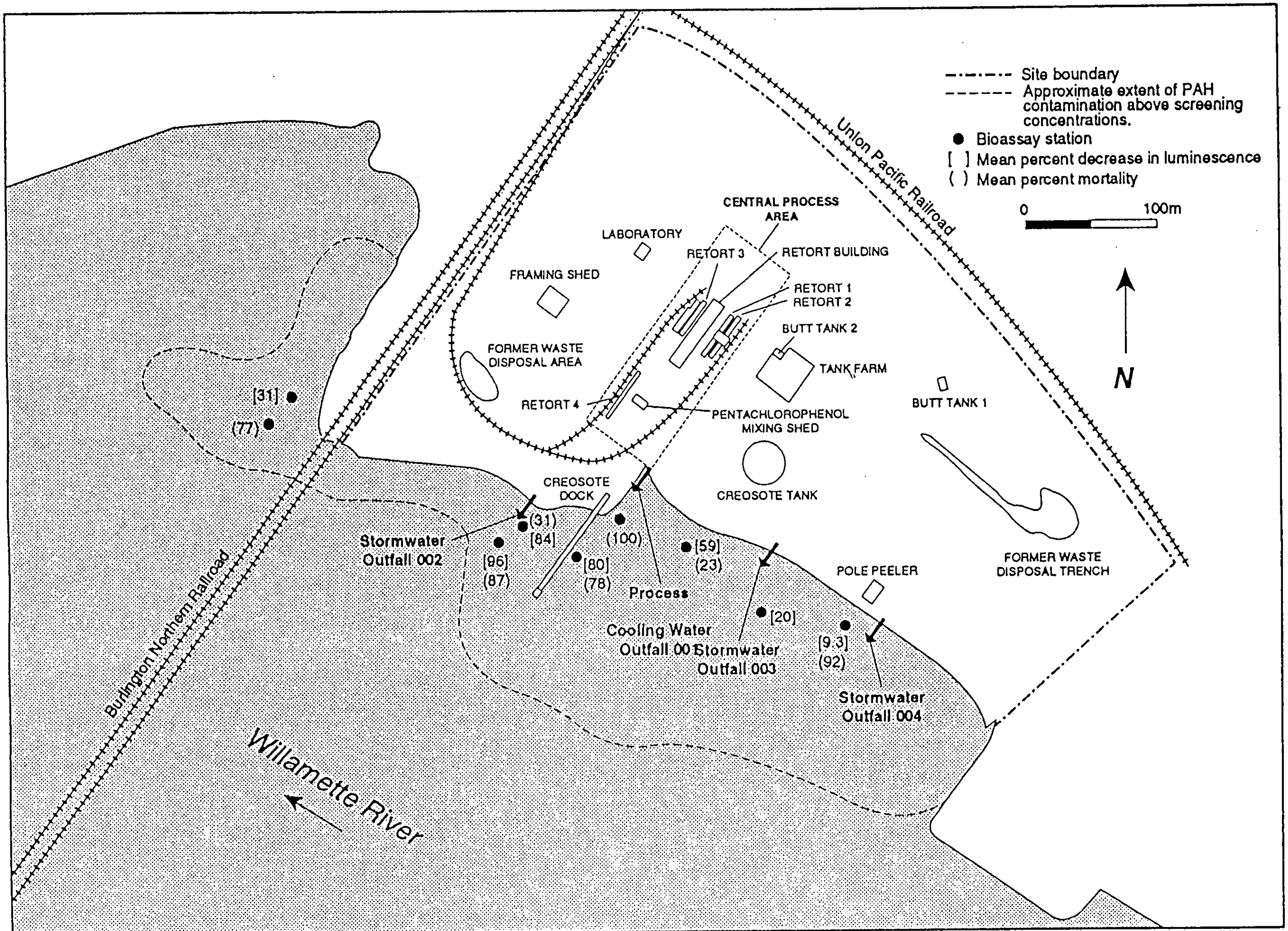

Figure 2. The McCormick & Baxter site in Portland, Oregon and approximate area of sediment contamination (PTI, 1992).

Numerous areas of contamination have been observed on the site, primarily in the central process area, tank farm, and at the former waste disposal area. Soils that are highly stained or saturated with hydrocarbons have been observed near the retorts, tank farm, creosote tank, butt tanks, pole peeler, and along the railways. Sinking product layers have been observed in numerous monitoring wells on the site, including those within 30 m of the Willamette River. Seeps of oily product have been observed on the shore of the river downgradient of the creosote tank and downgradient of the former waste disposal area in an embayment northwest of the site. Creosote and oil have been encountered in holes dug along the beach at a depth corresponding to the water table. In addition, bubbles of creosote and oil have been observed rising from nearshore sediments to the water surface near the creosote dock (PTI, 1992).

Releases of contaminants at the site to the environment were first reported to the Oregon Department of Environmental Quality (DEQ) in 1983. Subsequent investigations by McCormick & Baxter resulted in the signing of an initial stipulation and final order with DEQ in 1987. Responsibility for the site was transferred to the Environmental Clean-up Division of DEQ which began remedial investigations in 1990; the RI/FS was completed for the site in 1992 (PTI, 1992).

PATHWAY CHARACTERIZATION

The site is situated on the east bank of the Willamette River, the aquatic habitat of concern. The site is relatively flat and contains no permanent surface water bodies. The primary pathways for the transport of contaminants from the site to the Willamette River are groundwater discharge and the discharge of surface runoff through four outfalls (PTI, 1992).

Groundwater Pathway

Beneath the site, groundwater occurs in three aquifers: an unconfined water table aquifer, a semi-confined intermediate aquifer, and a confined deep aquifer. The shallow aquifer is generally found between 6 and 9 m below ground surface, the intermediate between 12 and 16 m, and the deep aquifer below 45 m. Silt-sand aquitards separate the three aquifers, although in some areas beneath the site the water table and intermediate aquifers are continuous. Groundwater flow in the water table aquifer is generally to the southwest, discharging to the Willamette River. Calculated groundwater flow is relatively slow, ranging from 20 to 187 m per year in the shallow aquifer and 1.5 to 4 m per year in the intermediate aquifer. Data were not sufficient to calculate flow of the deeper aquifer (PTI, 1992).

Surface Runoff Pathway

The river bank adjacent to the site is narrow and vegetated, dropping 6 meters (m) to a sandy river beach. Site runoff drains to the Willamette River through a series of drainage ditches, storm drains, and culverts that lead to outfalls (Figure 2). Outfall 001 was used as a conduit for waste fluids discharged directly to the Willamette River before 1971. From 1971 to the end of operations in 1991, Outfall 001 discharged process cooling water. Outfall 002 drained much of the central process area by a series of stormwater collection drains and culverts. An average annual discharge of 11,220,000 liters per year was estimated for Outfall 002 between 1987 and 1990. Currently, only paved paking lots runoff is directed to Outfall 002. Outfall 003 drained runoff from the area surrounding Retorts 1 and 2, the tank farm, and creosote tank. Discharge measurements were not collected for Outfall 003, and currently, this outfall has no flow. Outfall 004 does not receive substantial runoff because site grading has left it isolated: this outfall was found plugged and inactive in 1990. Stormwater discharge through Outfalls 001 and 002 is authorized under a National Pollutant Discharge Elimination System (NPDES) permit; the other outfalls are unpermitted (PTI, 1992).

No surface water treatment systems are in use for any of the outfalls. Overland runoff other than that from the outfalls is minimal. The site does not lie in the 100 year flood plain (PTI, 1992).

Other Transport Factors

Creosote was brought to the McCormick & Baxter facility by rail car and by ship. Spills occurring from vessels unloading creosote at the creosote dock is another potential pathway of contamination to the Willamette River. It is not known for how long creosote was shipped to the facility in this manner; unloading at the creosote dock was gradually phased out throughout the 1980s (PTI, 1992).

POTENTIALLY EXPOSED RESOURCES

Habitats at potential risk are surface waters and associated bottom substrates of the lower Willamette River. The Willamette River, the second largest tributary of the Columbia River, supports large salmonid populations (Haxton, personal communications, 1991). Spawning of anadromous species occurs throughout the upper river, upstream of the site. Substantial recreational fisheries are present on the river and annual stocking programs are currently used to sustain salmonid populations within the basin (Massey, personal communication, 1992).

Juvenile salmonids are known to utilize the Willamette River in the vicinity of the site as nursery habitat. Near the site, trust resources may be at risk due to extended periods of residence during sensitive early life stages.

Habitat Characterization

The Willamette River originates in the Cascade Range and flows north for approximately 420 km before discharging into the Columbia River, 160 km upstream from the Pacific Ocean. The site is approximately 11.3 km upstream from the confluence of the Willamette and Columbia Rivers. Surface waters in the vicinity of the site are tidal freshwater (Ward, personal communication, 1992). Water depth in dredged channles averages 12-14 m near the site, with a maximum depth of 24 m. There is a shallow bay nearshore tha covers over 8 hectares where depths are less than 3 m. River flow from 1987 to 1989 averaged between

685 and 825 cubic meters per second (cms) with a high of over 4,814 cms during January 1988 and a low of 198 cms during August 1988 (Farr and Ward, 1992).

Water quality in the Willamette River has diminished because of intensive urban, port, and industrial development, particularly in the lower basin (Ward, personal communication, 1992). Most development is on the lower Willamette River between River Kilometers 5 and 17, in and near the City of Portland. Habitat in the Willamette River near Portland has been altered to accommodate urban development and a growing shipping industry. Artificial structures (piers, wharves, etc.) in the harbor have changed the natural shoreline to rip-rap, bulkheads, and sand-beached lagoons. Because of dredging, the river has a steeply sloped, silt and sand bottom (PTI, 1992).

Although zoned for heavy industry, land use near the site is predominately light industrial and agricultural (Farr and Ward, 1992). Industrial activities are dominated by timber processing (PTI, 1992) and some chemical processing occurs across the river.

Resource Utilization

Chinook (two races), coho, and sockeye salmon and steelhead trout (two races) utilize the Willamette River near the site as a migratory corridor to upstream spawning grounds and as a nursery for juveniles. In general, chinook and steelhead populations are the largest and most widespread of the salmonids found in the river. Cutthroat trout are also present in the Willamette River, but their abundance is low (Bennett and Foster, 1991; Melcher, personal communication, 1992).

Table 1. NOAA trust species present in the Willamette River in proximity of the McCormick & Baxter site, primary habitat uses, and commercial and recreational fisheries (Melcher, personal communication, 1992; Ward, personal communication, 1992; Bennett and Foster, 1991; Farr and Ward, 1992).

Species		Habitat Use			Fisheries
Common Name	Scientific Name	Nursery Ground	Migration Route	Adult Forage	Recr. Fishery
ANADROMOUS SPECIES					
White sturgeon	*Acipenser transmontanus*	♦	♦	♦	♦
American shad	*Alosa sapidissima*	♦	♦	♦	♦
Coho salmon	*Oncorhynchus kisutch*	♦	♦		♦
Steelhead trout	*Oncorhynchus mykiss*	♦	♦		♦
Sockeye salmon	*Oncorhynchus nerka*	♦	♦		♦
Chinook salmon	*Oncorhynchus tshawytscha*	♦	♦		♦

Chinook Salmon

Two races of chinook salmon, spring chinook and fall chinook, use the Willamette River. These two sub-species are genetically distinct from one another. Spring chinook enter the river in peak numbers during the spring months, while fall chinook enter the basin during the fall.

During their annual migration, Willamette River spring chinook begin entering the Columbia River during January. Peak densities occur in late March, with entries tapering off by mid-May. Spring chinook migrate past the site, bound for tributary streams above Willamette Falls (located approximately 30 km upstream of the site). Spawning takes place in the early fall. Typically, juvenile spring chinook migrate to the ocean in the spring after rearing approximately 6 to 12 months in the river. They spend anywhere from 1 to 5 years in the ocean. The spring chinook run entering the Willamette River in 1990 (106,300) was the largest on record, up 30 percent from the previous 5 year average (81,900) (Bennett and Foster, 1991).

Five large hatcheries currently produce approximately 5 million smolt-size spring chinook for release into the Willamette River each year, plus additional fingerling salmon to seed underused reservoir and tributary streams. Current hatchery practices include the release of approximately two-thirds of the annual production of smolts in March as moderate-size yearlings and one-third in November as large subyearlings. Most of the smolts are released near the adult collection sites, but some are also trucked to areas within the lower Willamette River to increase survival. Stock size in the Willamette River and tributary streams are predicted to increase by approximately 10,000 salmon during the 1992 season (Bennett and Foster, 1991).

Fall chinook were introduced to the Willamette River in 1964. This sub-species spawns and rears in the main-stem of the upper Willamette River and lower reaches of east-side tributaries upstream of the site. Fall chinook begin entering the Columbia and Willamette Rivers in late August and runs taper off by mid-October. The spawning period typically occurs from mid-September to late October. Juveniles spend one year in freshwater before out-migration, which extends from mid-August through late September (Bennett and Foster, 1991). Fall chinook generally spend 2 to 5 years in the ocean before returning to the Willamette. Runs are supplemented by the addition of 5 to 7 million smolts each year. Total run size for fall chinook salmon have not been enumerated for the Willamette River (Melcher, personal communication, 1992).

Steelhead Trout

Similar to chinook salmon, two races of steelhead trout are present on the Willamette River–winter run and summer run, each named for the time period in which spawning runs begin. The Willamette River winter steelhead run occurs during the late winter to spring with trout migrating upstream from February through May. Spawning occurs from March through May. Naturally-spawned juveniles generally spend two years in freshwater before smolting;

out-migration begins in early April and extends through June. Runs have been supplemented by hatchery stocks since the 1960s; in 1991, approximately 565,000 winter steelhead smolts were released in the Willamette River basin as age 1+ smolts (Massey, personal communication, 1992; Mamoyac, personal communication, 1992; Bennett and Foster, 1991).

Summer steelhead begin entering the Willamette River starting in early March migrating to spawning grounds above Willamette Falls. Peak migrations occurs from mid-May through June. Adult fish remain in the river through the fall and spawn during the winter months. The majority of returning adults spend two years in saltwater. Summer steelhead were introduced above Willamette Falls in the late 1960's for sport fishing. Natural production is low and is monitored closely by the Oregon Department of Fish and Wildlife to ensure populations are sustained by hatchery releases and angling regulations (Massey, personal communication, 1992). In 1991, approximately 750,000 summer steelhead smolts were released in the Willamette River basin. Total run size for winter and summer run steelhead have not been enumerated for the Willamette River (Massey, personal communication, 1992; Mamoyac, personal communication, 1992).

Coho Salmon

Coho migrate up the Willamette from late August through early November with peak numbers beginning in mid to late September. Spawning occurs from September through December and juveniles outmigrate the following spring. Coho return to freshwater as age-3 adults and age-2 jacks (precocious male adults). Due to concerns regarding competition between coho salmon and other game fish and a lack of contribution to Willamette River fisheries, the management of coho runs have been de-emphasized. Total run size for coho salmon have not been enumerated for the Willamette River (Bennett and Foster, 1991).

Sockeye salmon

Sockeye salmon are not indigenous to the Willamette River. Experimental releases were conducted 1966 and 1967 with 143,000 Columbia River sockeye and 243,000 Adams River (British Columbia) sockeye introduced into up-river reservoirs. Adults from these releases returned in 1970 and 1971 and were allowed to spawn naturally. No further releases were made as natural reproduction has continued. Since the first introduction, the population of sockeye salmon in the Willamette has decreased considerably. The Willamette River Basin Fish Management Plan proposes to eliminate the sockeye run from the Willamette River. Total run size for sockeye salmon have not been enumerated for the river (Bennett and Foster, 1991).

American shad

American shad are not indigenous to the Willamette River, but were introduced to the Columbia Basin early in the century. Shad enter the lower Willamette River and migrate upstream to Willamette Falls from mid-May to mid-July, peaking in June. Shad rarely use the Willamette Falls fishway due to structural limitation that inhibit the species from proceeding upstream. Data for sport catch indicate that shad are abundant in the Willamette River, but spawning location and general resource utilization by the species is unclear

(Melcher, personal communication, 1992). The shad fishery is presently underutilized and management of the species is considered unnecessary.

White sturgeon

White sturgeon are plentiful throughout the lower Willamette River and transplants have established a small resident population above Willamette Falls. Most white sturgeon spawn immediately below Willamette Falls, upstream of the site, during the late fall and winter. Juveniles are present in the river year round and congregate in the Portland area in the vicinity of the site. Sturgeon have been stocked in limited numbers (approximately 1,000 to 2,000 per year) above the falls for the last three years (Bennett and Foster, 1991).

Commercial and Recreational Fisheries

No commercial fisheries for the anadromous salmonids are present on the Willamette River (Melcher, personal communication, 1992). However, the Columbia River supports a valuable commercial fishery. Due to precipitous declines in stocks, stock preservation activities, competing fishing gears, and conflicting uses of the Columbia River (*e.g.*, hydropower and shipping), commercial fisheries are highly regulated in that river (Bennett and Foster, 1991).

Recreational fishing is extremely popular throughout the lower Willamette basin. Species most desired are spring chinook, steelhead, coho, shad, and white sturgeon (Melcher, personal communication, 1992; Haxton, personal communication, 1991). Spring chinook contribute substantially to the main-stem Columbia River sport fishery and consistently supports the largest recreational fishery in the lower Willamette River. The chinook fishery in the Willamette River occurs between Oregon City and the confluence of the Willamette and Columbia River and throughout the Multnomah Channel. The site is located within this 75-km reach and recreational angling may occur in the general vicinity of the site. Angling is conducted primarily from anchored or slow-moving boats. Recently a bank fishery has developed popularity along the Multnomah Channel downstream of the site. The Willamette River recreational catch for Spring chinook often peaks in April. Total sport catch in the Willamette River for 1990 totaled 78,000 fish; approximately 30 percent of this catch was landed in the lower Willamette River (Bennett and Foster, 1991).

Steelhead catch data are not collected during peak angling periods in December and January. Spring chinook anglers incidentally caught a total of 552 steelhead in the Willamette from March through late June 1990.

Peak effort for white sturgeon occurs during the spring and summer months of this year-round fishery. Although estimates were not available, harvest of legal sized sturgeon is considered to be less than 1,000 individuals per year. An estimated 181 legal-sized white sturgeon were caught from mid-March to June 1990 alone. The majority of sturgeon angling occurs upstream near Willamette Falls (Bennett and Foster, 1991).

An increasing boat fishery for shad occurs in the Multnomah Channel in the vicinity of Coon Island. The 1990 total estimated catch of 23,467 shad was the second highest of 15 years of records (Bennett and Foster, 1991).

CHEMICAL CONTAMINANTS OF CONCERN

The primary contaminants of concern to NOAA are several polycyclic aromatic hydrocarbons (PAHs) associated with creosote, PCP, chlorinated dibenzodioxins (CDDs), chlorinated dibenzofurans (CDFs), arsenic, chromium, copper, and zinc. These substances were detected at high concentrations in the soils and groundwater on the site, in surface water discharges to the Willamette River, and within the sediments of the Willamette River (PTI, 1992).

To identify substances that might pose a threat to NOAA trust resources, water samples were screened by comparing the measured contaminant concentrations with the applicable chronic ambient water quality criterion (AWQC) for the protection of aquatic organisms for those substances for which such criteria have been developed.[1] AWQC have not been developed for the CDDs or CDFs, except for the highly toxic 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). Concentrations of these organic compounds were screened on the basis of Toxicity Equivalent Factors (TEF) developed by U.S. EPA (1989) and reported as Toxicity Equivalent Concentrations of 2,3,7,8-TCDD.[2]

Very little information exists regarding the toxicity of contaminated soils or sediments. No criteria similar to the AWQC are available. For screening purposes, the trace element concentrations in soils were compared with the average concentrations found in soils of the United States.[3] For many of the substances, concentrations in sediments were screened by

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[1]Because releases from hazardous waste sites are often continuous and long term, chronic AWQC were used. Surface water concentrations were compared directly to AWQC. Groundwater concentrations were also screened against AWQC. On the basis of dilution expected during migration and upon discharge to surface water, the screening value used for groundwater samples was 10 times the AWQC applicable to the local surface water.

[2]The TEF method relates the toxicity of the 209 structurally related CDDs and CDFs to the highly studied 2,3,7,8-TCDD. In this method, 2,3,7,8-TCDD has a TEF of 1; TEFs for the other CDDs and CDFs are assigned on the basis of their toxicity relative to that of 2,3,7,8-TCDD. Since 2,3,7,8-TCDD is the most toxic homolog/congener, TEFs for the other CDDs and CDFs are less than 1 ranging from 0.00001 to 0.5. The toxicity of other CDDs and CDFs can be expressed as a Toxcity Equivalent Concentration of 2,3,7,8-TCDD and compared with the AWQC for that substance.

[3]NOAA screens soil concentrations only to estimate which trace elements may be elevated on-site and represent sources for potential contaminant migration. Until regional baseline levels in soils are available, national averages are used as a benchmark for comparison purposes only. Soil concentrations are not used for estimating exposure levels to aquatic species.

comparison with Effective Range-Low (ER-L) values reported by Long and Morgan (1990).[4] Substances that have no calculated ER-L values were compared with the lowest appropriate Apparent Effects Threshold (AET) value.[5]

A comprehensive environmental investigation was conducted on and off the McCormick & Baxter site. Sampling and chemical analyses of surface soil (30), sub-surface borings (30), groundwater (39 wells; 2 sampling rounds), water from the outfalls (3), river sediment (48 surface sediment; 32 sediment cores), and river biota (edible tissue analysis and histopathology) were conducted between 1990 and 1992. Surface sediment bioassays (*Hyalella azteca*) and pore water bioassays (Microtox) were also performed. Environmental media were analyzed for TCL substances, dioxins, and furans (PTI, 1992).

Source and Pathway Characterization

Polycyclic Aromatic Hydrocarbons (PAHs)

In aquatic environments, most PAHs are persistent, adsorb strongly to soils and sediments, demonstrate relatively low solubility in water and exhibit low mobility (Clement Associates, 1985). Sources of PAHs on the site are primarily associated with the Central Process Area, the Former Hazardous Waste Disposal Area, and the Tank Farms. PAHs are a major component of the product layers beneath the site. Contaminated surface water discharged through three of the four outfalls is another transport pathway (PTI, 1992).

Surface and sub-surface soils on the site are highly contaminated with PAHs (Table 2). The PAHs napthalene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, and benzofluoranthenes were observed in surface and sub-surface soils on the site at maximum concentrations between 1,000 and 5,000 mg/kg. In surface soils, concentrations of total PAHs consistently exceeded 1,000 mg/kg in four areas on the site: the Central Process Area near Retorts 1 and 2, the Tank Farm, inside of the Creosote Tank retaining wall, and near the Framing Shed northeast of the Former Waste Disposal Area. In sub-surface soils, the horizontal distribution of contamination was similar to that of surface soil contamination, with the addition of considerable contamination (>1,000 mg/kg) observed beneath the Former Waste Disposal Area. Very high concentrations have also been observed immediately downgradient of Retorts 1 and 2 in the Central Process Area and the Former Waste Disposal Area, suggesting horizontal migration at depth. Migration of contamination

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[4]The ER-L value is the concentration equivalent to that reported at the lower 10 percentile of the available screened sediment toxicity data. As such, it represents the low end of the range of concentrations at which effects were observed in the studies compiled by those authors. Although freshwater studies were included, predominantly marine and estuarine toxicity studies were used for generating ER-L values.

[5]AET relate the chemical concentrations in sediments to at least one biological indicator of injury (i.e., sediment bioassays or altered benthic infauna abundance) to determine the concentration of the contaminant above which biological effects would be expected (Barrick et al. 1988). AET values were developed for use in Puget Sound, Washington.

Table 2. Concentrations (mg/kg) of contaminants of concern in surface and subsurface soils on-site and sediments in the Willamette River (PTI, 1992) compared with ER-L values (Long and Morgan, 1990).

	SOILS						SEDIMENTS		
	Surface		Sub-surface		Retort Pad		Willamette River		ER-L
Contaminant	Min	Max	Min	Max	Min	Max	Min	Max	
ORGANICS									
naphthalene	0.06	42	<0.011	23,000	0.011	100	<0.013	3,500	0.34
acenaphthylene	0.62	50	<0.011	1.1	0.011	5	<0.013	17	1.3
acenaphthene	0.021	940	0.013	870	0.011	240	<0.025	1,300	0.15
flourene	<0.021	1,300	<0.011	790	0.011	270	<0.013	1,100	0.035
phenanthene	0.48	4,900	<0.011	1,400	0.011	500	<0.016	1,900	0.225
anthracene	0.33	2,600	<0.011	250	0.011	150	<0.013	290	0.085
fluoranthene	0.73	2,900	<0.011	700	0.011	530	0.039	960	0.06
pyrene	0.58	1,600	<0.011	380	0.011	400	0.045	610	0.35
chrysene	0.6	1,900	<0.011	88	0.011	200	0.026	170	0.40
benzofluoranthenes	1.6	1,000	<0.011	100	0.011	110	0.044	170	3.2
benzo(a)pyrene	<0.022	210	<0.011	28	0.011	52	0.019	58	0.40
benzo(e)pyrene	<0.022	620	<0.011	3.1	0.011	130	<0.013	50	N/D
pentachlorophenol	0.88	4,800	<0.011	260	0.11	380	<0.0024	7.2	0.69
CDDs/CDFs*	0.046	0.38	9.0×10^{-7}	0.034	NT	NT	1.3×10^{-5}	0.0027	N/D
INORGANICS									
arsenic	1.1	5,100**	1.2	30	2.5	4,400**	2.1	18	33
chromium	9.6	720	5.7	74	9.5	550	1.1	48	80
chromium^{+6}	0.05	11	0.03	0.9	NT	NT	0.07	0.99	N/D
copper	11	3,600**	11	63	12	5,200**	12	330	70
zinc	35	4,200**	33	190	32	530**	35	350	120

N/D: Screening concentrations not determined.
NT: Not tested.
* Toxicity equivalent concentrations of 2,3,7,8-TCDD.
** Exceed average concentrations in U.S. soils reported by Lindsay (1979) by over an order of magnitude.

in the soils at depth may have occurred with local groundwater flow, since contaminated soils have been observed within the shallow water table. Concentrations of total PAHs above 1,000 mg/kg have been observed at depths between 3 and 8 m below ground surface downgradient of the retorts and Former Waste Disposal Area (PTI, 1992). NOAA screening concentrations for PAHs in soils have not been developed.

Floating and sinking product layers have been observed in the groundwater at substantial quantities. These product layers represent not only a significant source of contamination, but also document environmental migration of site-related contamination. Where observed, sinking product has been measured up to 6.5 m thick in the groundwater and floating product up to 2.2 m thick. Concentrations of PAHs in product layers are at percent levels, well in excess of groundwater screening concentrations. Maximum concentrations of total PAHs exceed 250,000,000 µg/l (25 percent; Table 3). Floating product was observed on the shallow water table beneath the Former Waste Disposal Area, the Central Process Area and Tank Farm Area southward toward the beach, and beneath Former Butt Tank 1. The greatest amount of floating product (2.2 m thick) was observed in the Former Waste Disposal Area. In the remaining areas, product thickness was generally a thin film (PTI, 1992).

Table 3. Concentrations (µg/l) of selected contaminants of concern detected in product layers, groundwater, and stormwater outfalls (PTI, 1992) compared with freshwater AWQC for the protection of aquatic life (U.S. EPA, 1986).

	Product Layers		Groundwater		Stormwater Outfalls		AWQC chronic
Contaminant	Min	Max	Min	Max	Min	Max	
ORGANIC COMPOUNDS							
naphthalene	$16x10^6$	$90x10^6$	<1	$2.4x10^6$	ND	ND	N/D[a]
acenaphthylene	100,000	490,000	<1	150,000	ND	ND	N/D[a]
acenaphthene	$15x10^6$	$30x10^6$	<1	$2x10^6$	ND	ND	520
flourene	100,000	$36x10^6$	<1	$1.8x10^6$	ND	ND	N/D[a]
phenanthene	$21x10^6$	$88x10^6$	<1	$3.9x10^6$	ND	ND	N/D[a]
anthracene	$4.4x10^6$	$8.2x10^6$	<1	620,000	ND	ND	N/D[a]
fluoranthene	$9x10^6$	$32x10^6$	<1	$2x10^6$	<1	4	N/D[a]
pyrene	$6.1x10^6$	$30x10^6$	<1	$1.1x10^6$	<1	2	N/D[a]
chrysene	$1.7x10^6$	$4.5x10^6$	<1	190,000	ND	ND	N/D[a]
benzofluoranthenes	700,000	$1.7x10^6$	<1	160,000	ND	ND	N/D[a]
benzo(a)pyrene	100,000	100,000	<1	100,000	ND	ND	N/D[a]
benzo(e)pyrene	100,000	100,000	<1	5,300	ND	ND	N/D[a]
pentachlorophenol	500,000	$8.2x10^6$	<5	$1.2x10^6$	5	1,700	13[b]
CDDs/CDFs[c]	0.0046	0.2	NA	NA	$1.9x10^{-5}$	0.24	<0.00001
INORGANIC SUBSTANCES							
arsenic	NT	NT	<1	9,000	2.3	7,600	190[d]
chromium	NT	NT	<2	12,000	<3	780	210+
$chromium^{+6}$	NT	NT	<2	120	<3	19	11
copper	NT	NT	3.6	5,400	<2	15,000	12+
zinc	NT	NT	8.4	260,000	1.9	8,200	110+

N/D: Screening concentrations not determined.
NT: Not tested.
\+ Hardness dependednt criteria

a: The acute marine AWQC for ΣPAHs is 300 µg/l.
b: pH dependednt criteria
c: Toxicity equivalent concentrations of 2,3,7,8-TCDD.

Sinking product is considerably thicker and more widespread beneath the site, found both within and below the shallow water table. Sinking product was found within the water table aquifer beneath the Former Waste Disposal Area, Central Process Area, Tank Farm, Former Butt Tank 1, and Former Waste Disposal Trench. Below the water table, within the intermediate aquifer, sinking product is present and is migrating beneath the Tank Farm and Former Waste Disposal Area. Beneath the Tank Farm, product sinks through the water table as it moves away from the source. The aquitard pinches off and often is not present between the two aquifers, thus allowing break-through into the intermediate aquifer below. Once sinking product reaches the intermediate aquifer near the beach, migration continues unimpeded into sediments of the Willamette River. Similarly, beneath the Former Waste Disposal Area, sinking product has migrated vertically and downgradient into the river sediment. This migration is largely unimpeded because no aquitard is present between the water table and intermediate aquifers in this area (PTI, 1992).

Concentrations of dissolved-phase PAHs in the groundwater were also very high, generally only an order of magnitude lower than the percent levels observed in product layers (Table 3). Maximum concentrations of individual PAHs ranged from 5,300 μg/l to 3,900,000 μg/l; total PAHs were observed in excess of 10,000,000 μg/l. The spatial distribution of PAHs in the dissolved phase was similar to that of the product layers. The highest concentrations were found in the shallow and intermediate groundwater beneath the Former Waste Disposal Trench, the Central Process Area, and the Tank Farm extending to the river, and at the former Waste Disposal Area (PTI, 1992).

PAHs were not observed in water samples collected from outfalls that discharge site-related effluents to the river (PTI, 1992).

Pentachlorophenol (PCP)

PCP is a persistent organic compound, adsorbs strongly to soils and sediments, has low solubility in water and exhibits low mobility. Compared to the PAHs, PCP is more soluble and is expected to be more mobile in the environment and may migrate farther off-site (PTI, 1992).

PCP was observed to be widespread in surface and sub-surface soils on-site, with similar concentrations and a similar spatial distribution pattern as the PAHs (Table 2). High concentrations in surface soils were observed in the Central Process Area; however, the highest concentrations were near Retort 4. PCP was the primary substance used in this retort. In sub-surface borings, high concentrations were again observed near Retort 4, the railway that serves it, the Former Waste Disposal Area, and the area immediately downgradient thereof. Concentrations between 100 and 1,000 mg/kg were observed between 1.5 and 9 m below ground surface (PTI, 1992). NOAA screening concentrations for PCP in soils have not been developed.

PCP was also a substantial component of floating and sinking product observed within the groundwater. Concentrations were of the same magnitude as individual PAHs, with a maximum of over 1,000,000 μg/l, well in excess of groundwater screening concentrations. PCP in dissolved phase was also observed at orders of magnitude above screening concentrations in the same areas of high PAH contamination (Table 3). In contrast to the PAHs, however, concentrations of PCP in the intermediate wells were higher than in corresponding shallow wells. This is consistent with the expected chemical behavior of the substance. PCP, which is predominantly in an anionic form under the pH conditions found in the groundwater beneath the site, would be expected to be more mobile than the PAHs, and therefore would migrate more readily downward to the intermediate aquifer (PTI, 1992).

PCP was detected in water amples from three outfalls. In six of seven outfall samples collected, concentrations of PCP far exceeded ambient water quality criteria. In Outfalls 002 and 003, concentrations exceeded screening concentrations by over an order of magnitude (PTI, 1992).

Chlorinated Dibenzodioxins and Chlorinated Dibenzofurans (CDDs and CDFs)

The CDD and CDF families of organic compounds are by-products of the PCP manufacturing process. They can also be formed by the combustion of PCP treating solution. Many of these organic compounds, particularly 2,3,7,8-TCDD are extremely persistent and highly toxic. Toxicity to aquatic organisms has been observed at the parts per trillion level (Eisler 1986). Concentrations of CDDs and CDFs are expressed as 2,3,7,8-TCDD toxicity equivalents (Tables 2 and 3).

CDDs and CDFs do not appear to be as widespread on the site as the PAHs and PCP. These substances generally appear in association with the most contaminated areas, particularly those with the highest concentrations of PCP. The highest concentrations of CDDs and CDFs in surface soils were associated with Retort 4 in the Central Process Area, where the highest concentrations of PCP were also found. However, analyses for CDDs and CDFs in surface soils were not conducted away from the Central Process Area, therefore it is not fully known to what extent other areas are contaminated. Contamination by CDDs and CDFs in sub-surface borings also appears to be associated with areas of gross contamination (i.e., visibly contaminated soils). CDDs and CDFs have been observed in soils collected from 7m beneath Retort 4, the Former Waste Disposal Area, and immediately downgradient thereof in samples that were also highly contaminated with PCP and PAHs (PTI, 1992). NOAA screening concentrations for CDDs and CDFs in soils have not been developed.

A similar trend in residues was observed in samples of product collected from the the shallow groundwater. CDDs and CDFs were observed in product downgradient of the Central Process Area near the river and near the Former Waste Disposal Area in samples that contained the highest concentrations of PCP. Concentrations observed exceeded groundwater screening concentrations by up to three orders of magnitude in product layers (Table 3). CDDs and CDFs were not analyzed for in dissolved-phase groundwater samples (PTI, 1992).

Toxicity equivalent concentrations of 2,3,7,8-TCDD were observed in three outfalls, and concentrations in outfalls 002 and 003 exceeded ambient water quality criteria by up to four orders of magnitude (Table 3) (PTI, 1992).

Trace Elements

The trace elements arsenic, chromium (total chromium and hexavalent chromium), copper and zinc were observed at elevated concentrations in source areas on the site (PTI, 1992). These elements are persistent environmental contaminants that tend to adsorb to particulates and sediments, are toxic at relatively low concentrations, and can bioaccumulate in aquatic organisms (Clement Associates ,1985).

Elevated concentrations of arsenic, chromium, copper and zinc on the site were generally limited to the Central Process Area and Tank Farm. The highest concentrations were observed in the Central Process Area where ACZA was used. In surface soils, concentrations of arsenic, copper, and zinc exceeded average concentrations in U.S. soils (Lindsay, 1979) by up to two orders of magnitude (Table 2). The highest concentrations of arsenic were observed near the ACZA Tank in the Central Process Area. Total chromium concentrations were highest near the Framing Shed, while maximum hexavalent chromium concentrations were observed near the Pole Peeler and Framing Shed. Elevated concentrations of copper were widespread. Concentrations over 1,000 mg/kg were observed near the ACZA Tank, Retort 4, the Creosote Tank, and Framing Shed. Zinc was observed at elevated concentrations in only one sample near the ACZA Tank. Trace element concentrations were generally not elevated in sub-surface soils except in the shallow sub-surface near the retorts. In the latter location, arsenic, copper, and zinc measurements exceeded average soil concentrations by up to two orders of magnitude (PTI, 1992).

Unlike the soils, where trace elements were observed most frequently in the Central Process Area and Tank Farm, groundwater contamination by metals resembles the pattern observed for organic contaminants. Concentrations of all four metals greatly exceeded groundwater screening concentrations in the Central Process Area, downgradient thereof near the river, and beneath the Former Waste Disposal Area. Concentrations were similar in both the shallow and in the intermediate aquifer. The deep aquifer is relatively uncontaminated (Table 3). Product layers were not analyzed for metals (PTI, 1992).

Concentrations of arsenic, total and hexavalent chromium, copper, and zinc in water samples from Outfalls 002 and 003 exceeded screening concentrations (*i.e.*, AWQC). Arsenic, copper, and zinc in both outfalls exceeded ambient water quality criteria by an order of magnitude (Table 3) (PTI, 1992).

Habitat Characterization

PAHs

PAHs have migrated from source areas on the site to the adjacent Willamette River. Although this area of the river is highly industrialized and other sources of PAHs are likely present, the proportional concentration of individual PAHs, and the concentrations gradients observed in the river indicate that contamination is site-related and is unrelated to other possible upstream or nearby sources (PTI, 1992).

Habitats in the Willamette River most contaminated by PAHs are river sediment. Concentrations of all of the PAHs observed in environmental media on-site were observed in river sediment at concentrations exceeding screening levels. Ten PAHs exceeded screening concentrations by up to three orders of magnitude (Table 2). Sediments contaminated with PAHs extend along the entire shoreline of the site and about two-thirds of the way into the embayment northwest of the site (Figure 2). The most contaminated sediments were found in two areas. The first area was in the vicinity of the creosote dock, extending downstream to a sandbar and upstream along the shoreline. Upstream contamination is likely due to migration from the Central Process Area and Tank Farm. The second area was in the embayment northwest of the site, a likely receptor of contaminant migration from the Former Waste Disposal Area. Oily seeps observed on the beach between the Former Waste Disposal Area and river appear to confirm the source and pathway for this contamination (PTI, 1992).

Results of sediment core studies are preliminary (evaluation of sediment cores samples is not complete), but the presence of PAHs in sediments above screening concentrations were observed as deep as 2 m below the surface (PTI, 1992). Qualitative observations from sediment cores indicate that sinking product layers have penetrated sub-surface sediments in the river. Visual evidence and hydrocarbon odors have been observed in sediment cores as deep as 20 m into sediments.

PCP

Relatively low concentrations of PCP were observed in the sediment compared to the PAHs. However, concentrations exceeding the screening concentrations were observed in river sediment downgradient of the Central Process area, around the creosote dock, and downgradient of the Former Waste Disposal Area (Table 2). Concentrations were generally within an order of magnitude of the PCP screening concentration, unlike the extensive contamination of the sediments by PAHs (PTI, 1992).

CDDs and CDFs

Elevated concentrations of CDDs and CDFs were observed within the sediments adjacent to the site (Table 2). The highest concentrations were observed near the Creosote Dock; elevated concentrations were also observed downgradient of the Former Waste Disposal Area (PTI, 1992). No screening concentrations or sediment guidelines are available for the CDDs and CDFs in sediment.

Trace Elements

Concentrations of the trace elements in river sediments were generally not elevated above screening concentrations (Table 2). Copper and zinc were elevated above screening concentrations at only three stations, two upstream of the Central Process Area and one station downstream of the Railroad bridge. These elevated concentrations may or may not be site-related (PTI, 1992).

EFFECTS ON HABITATS AND SPECIES

The environmental receptors most likely to be affected by contaminants associated with the McCormick & Baxter site are those which use the aquatic habitats in the tidal riverine portions of the Willamette River. Near the site, the river provides nursery habitat for important anadromous salmonids and is a migratory corridor on one of the most prolific anadromous fish basins on the West Coast. Sensitive early life stages utilizing this reach of the river may be exposed to potentially toxic levels of PAHs, PCP, CDDs, CDFs, arsenic, chromium, copper, and zinc.

Measured Impacts

Bioassessment studies conducted as part of environmental investigations at the site include sediment bioassays, bioaccumulation tests, and tissue histopathology (PTI, 1992).

Bioassays using the freshwater amphipod *Hyalella azteca* and the Microtox® test were performed with sediments collected from the Willamette River near the McCormick & Baxter facility. Significant mortality (compared to reference sediments; $\rho \leq 0.05$) was observed along the entire nearshore adjacent to the site at several stations tested for toxicity to *Hyalella*, and several stations tested for Microtox® luminescence (Figure 2). The highest mortalities and decreases in luminescence were found in the area of the Creosote Dock, downgradient of the Central Process Area, and near the railroad bridge. The highest toxicity (100 percent mortality; 82 percent decrease in luminescence) was observed at two stations near the dock. Substantial affects (31 to 87 percent mortality; 84 to 96 percent decreases in luminescence) also appear associated with sediment near Outfall 002, the outfall draining most of the Central Process Area (PTI, 1992).

Based on the bioassays performed during the RI/FS, sediments at the site have significant adverse effects on both the microorganisms used in the Microtox® test and *Hyalella*. Contaminated sediments impacting bioassay species are distributed adjacent to the site from the Central Process Area to below the railroad bridge. These data indicate the possibility that other benthic organisms, some of which may be ecologically important to NOAA trust resources, may be adversely impacted in areas of the river near the site.

Bioaccumulation studies reporting wet weight concentrations in the edible muscle tissue of crayfish and largescale sucker were conducted during RI/FS investigations. Naphthalene (20 µg/kg to 60 µg/kg) and acenapthene (21 µg/kg) were observed in edible tissues of crayfish. Napthalene (28 to 55 µg/kg), acenaphthene (18 to 30 µg/kg), and fluorene (19 to 28 µg/kg) were observed in largescale sucker. No gradients of concentrations were observed among the five stations downstream of the site; however, concentrations of PAHs were elevated above the upstream reference stations. These data provide evidence of the on-going uptake of PAH contamination potentially associated with the site. PAHs are metabolized in aquatic organisms and detectable quantities are rarely found in tissue sample analyses (PTI, 1992).

Individual CDDs and CDFs were observed in the edible tissues of crayfish and sucker at concentrations above those found at reference stations ranging from 0.04 to 71 ng/kg. Highly toxic 2,3,7,8-TCDD was reported at concentrations between 0.7 and 2.1 ng/kg in sucker and 0.32 and 1.9 ng/kg in crayfish. A comparison of CDD and CDF tissue data from samples collected near the site with data from recent studies of local rivers conducted by DEQ (1990) and U.S. EPA (1987) found that, generally, the range of tissue concentrations near the site were similar to other industrial areas on local rivers. This suggests that bioavailable concentrations of CDDs and CDFs near the site may not be elevated compared to other industrial areas (PTI, 1992).

PCP and the trace elements were generally not elevated in the edible tissue of crayfish and sucker collected near the site (PTI, 1992).

The liver tissues of 249 largescale suckers collected near the site and reference areas were examined for histopathological abnormalities. The most commonly observed abnormality (found in 66 percent of fish) was the presence of mononuclear cell infiltrates, an indication of mild liver inflamation. However, there were no statistical differences between the prevalence of this condition in pooled stations near the site and its prevalence at the reference area. There was no evidence of more serious injury (e.g., neoplasia or megalocytic hepatosis) in any of the fish livers examined. In a separate study, preliminary data reported by Curtis (1991) indicate that fish collected from River Kilometer (Rkm) 11 (the approximate location of the site) receive the highest exposure to organic contaminants of any fish collected from six developed areas of the Willamette River. Carp collected from Rkm 11 in 1988, 1989, and 1990 exhibited several mild liver abnormalities including liver cirrhosis, influentia, perichlangitis, fibrosis, bile duct reduplication, and hemosiderin pigment. These findings are consistent with those found during RI/FS investigations near the site (PTI, 1992).

Predicted Impacts

High concentrations of PAHs and trace elements are present in, and discharging to sediments of the nearshore adjacent to the site at concentrations toxic to bottom-dwelling organisms in laboratory tests. High concentrations of PAHs, PCP, arsenic, chromium, copper, and zinc have also been observed in the groundwater beneath the site. According to toxicity data, particularly for sensitive species such as the Pacific salmonids, concentrations within the sediments and groundwater may be harmful to sensitive species in the nearshore areas of the Willamette River.

PAHs

Anadromous Pacific salmonids, particularly early life stages, are more sensitive to some of the PAHs than most other organisms used in toxicity tests. In an extensive compilation of studies showing the effects of PAHs, Eisler (1987) reported toxicity to salmonids at surface water concentrations ranging from 820 to 3,200 µg/l.

PAHs can accumulate in the tissues of aquatic organisms, although levels of accumulation are usually lower in fish than in other aquatic organisms because fish metabolize PAHs rapidly. Bioconcentration factors in the liver of rainbow trout (*Oncorhynchus mykiss*) are reported at 379 for fluoranthene and 182 to 920 for benzo(a)pyrene. Uptake and accumulation can occur through the food chain (Eisler, 1987).

Concentrations of several PAHs in the groundwater beneath the site exceeded values where toxic responses have been observed in laboratory studies. PAHs exceeded the concentrations shown to be toxic by several orders of magnitude.

PCP

Anadromous Pacific salmonids are also more sensitive to PCP than other aquatic species tested. This compound has been found to be acutely toxic (LC_{50}) to salmonid species at concentrations between 34 and 157 µg/l. Chronic effects have been observed at lower concentrations. Reduced growth (10 to 19 percent reduction) has been observed in sockeye salmon (*O. nerka*) and rainbow trout (*O. mykiss*) upon exposure to PCP at concentrations between 3.2 and 28 µg/l (U.S. EPA, 1980). As with the PAHs, concentrations of PCP in the groundwater, as well as in waters of the outfalls, exceed concentrations shown to be toxic by several orders of magnitude.

CDDs and CDFs

Data indicate that Pacific salmonids are sensitive to 2,3,7,8-TCDD. Juvenile coho salmon exposed to 0.56 ng/l 2,3,7,8-TCDD for 48 hours experienced an increased mortality over the following 60 days (12 percent). Mortality increased to 55 percent over the same period at an exposure of 5.6 ng/l. Rainbow trout exposed to 10 ng/l 2,3,7,8-TCDD for 96 hours experienced increased mortality (26 percent) and growth retardation over the next 72 days (Eisler, 1986). These data indicate long term-effects with relatively short-term exposures. Data from the site indicate that these types of exposures are possible when highly contaminated groundwater discharges to the river.

Trace Elements

Anadromous Pacific salmonids are very sensitive to many of the trace elements, particularly copper. Copper has been found to be acutely toxic (LC/EC_{50}) to these species at concentrations of 7 to 1,100 µg/l. Avoidance to copper has been observed in rainbow trout (*O. mykiss*) at concentrations as low as 0.1 µg/l (U.S. EPA, 1985). For zinc, acute toxicity to Pacific anadromous salmonids has occurred between 97 and 6,400 µg/l (U.S. EPA, 1987). Comparable values for arsenic range from 130 µg/l (alevins) to 26,600 µg/l (adults) (Eisler, 1988). Pacific salmon have shown acute toxicity to chromium at concentrations as low as 200 µg/l. Rainbow trout have shown toxic responses at concentrations ranging from 3,400 to 65,500 µg/l, depending upon juvenile life stage and pH. Again, concentrations of trace elements in the groundwater and in the outfalls were orders of magnitude above the lowest concentrations eliciting toxic responses.

REVIEW

The McCormick & Baxter site occupies 23 hectares on the bank of the Willamette River, an important anadromous fish stream. The McCormick & Baxter Company treated wood from 1944 to 1991 using creosote, pentachlorophenol, and copper-, chomium-, and zinc-based preservatives. Soils and sub-surface soils are highly contaminated with these substances as well as with CDDs and CDFs. The groundwater beneath the site is grossly contaminated with floating and sinking product layers and dissolved phase contaminants. Historically, up to four outfalls have discharged to the river and site-related contamination has been observed in discharges from some of these outfalls. Oily seeps have been observed on the beach adjacent to the site.

The sediments of the Willamette River adjacent to the site are contaminated with site-related organic and inorganic substances at concentrations exceeding screening concentrations. Very high concentrations have been observed in river sediment as deep as 2 m below river bottom and likely extend deeper. Sediment and pore water bioassays indicate that contaminated sediments adjacent to the site are toxic to aquatic life. Bioaccumulation studies indicate that PAHs are bioavailable and have accumulated in the edible tissues of resident biota. Histopathological studies have found evidence of mild chronic affects, but substantial impacts to resident populations have not been observed.

The Willamette River near the site serves as a migratory corridor for adult anadromous salmonids and a nursery area for outmigrating juvenile salmonids. Large recreational fisheries are present on the reach of the river in the general vicinity of the site. The Willamette River is the second largest tributary stream in the Columbia basin, which is the most prolific salmonid watershed on the West Coast. A large management effort for the continuing production of salmonids is present on the Willamette River.

REFERENCES

Barrick, R., S. Becker, L. Brown, H. Beller, and R. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Prepared for Puget Sound Estuary Program, U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA. PTI Environmental Services, Bellevue, WA. 74 pp. + appendices.

Bennett, D.E. and C.A. Foster. 1991. 1990 Willamette River spring chinook salmon run, fisheries, and passage at Willamette Falls. Oregon Department of Fish and Wildlife, Columbia River Management. Portland, Oregon.

Clement Associates. 1985. Chemical, physical, and biological properties of compounds present at hazardous waste sites. U.S. Environmental Protection Agency, Washington, DC.

Eisler, R. 1986. Dioxin hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Report 85 (1.8). U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD. 37 pp. +

Eisler, R. 1987. Polycyclic aromatic hydrocarbons hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Report 85(1.12). U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Eisler, R. 1988. Arsenic hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Report 85(1.6). U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Farr, R.A., and D.L. Ward. 1992. Fishes of the lower Willamette River, near Portland, Oregon. Oregon Department of Fish and Wildlife, Research and Development. Clackamas, Oregon.

Haxton, J.C. 28 January, 4, February, 1991. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, Northwest Region, McMinnville, Oregon.

Lindsay, W.L. 1979. Chemical equilibria in soils. John Wiley & Sons, New York, NY. 449 pp.

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. NOAA Tech. Memo. NOS OMA 52. National Oceanic and Atmospheric Administration, Seattle, WA. 175 + appendices.

Mamoyac, S. 29 May 1992. Personal Communication. Fishery Biologist, Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Massey, J. 29 May 1992. Personal Communication. Fishery Biologist, Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Melcher, K. 28 May 1992. Personal Communication. Fishery Biologist, Oregon Department of Fish and Wildlife, Clackamas, Oregon.

PTI Environmental Services. 1992. Draft Remedial investigation report, Volume I of IV. Prepared for Oregon Department of Environmental Quality, Portland, Oregon.

U.S. EPA. 1980. Ambient water quality criteria for pentachlorophenol. EPA 440/5-80-065. U.S. Environmental Protection Agency, Office of Water Regulations and Standards Criteria and Standards Division, Washington, DC.

U.S. EPA. 1985. Ambient water quality criteria for copper - 1984. EPA 440/5-84-031. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC.

U.S. EPA. 1986. Quality criteria for water. Washington, D.C.: U.S. Environmental Protectic Agency. Office of Water Regulations and Standards.

U.S. EPA. 1987. Ambient water quality criteria for zinc. EPA 440/5-87-003. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC.

U.S. EPA. 1989. Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and -dibenzofurans (CDDs and CDFs) and 1989 update. EPA/625/3-89/016. U.S. Environmental Protection Agency, Washington, DC. appendices.

Ward, D. 27 May 1992. Presonal Communication. Fishery Biologist, Oregon Department of Fis and Wildlife, Clackamas, Oregon.

APPENDIX C

National Marine Fisheries Service Listed Species ESU Description

Chinook Salmon (*Oncorhynchus tshawytscha*)

Lower Columbia River ESU

Critical habitat is proposed to include all river reaches accessible to Chinook salmon in Columbia River tributaries between the Grays and White Salmon Rivers in Washington and the Willamette and Hood Rivers in Oregon, inclusive. Also included are river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to The Dalles Dam. Excluded are areas above specific dams or above long-standing, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 6,338 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Klickitat, Lewis, Pacific, Skamania, and Wahkiakum.

Upper Willamette River ESU

Critical habitat is proposed to include all river reaches accessible to Chinook salmon in the Willamette River and its tributaries above Willamette Falls. Also included are river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to and including the Willamette River in Oregon. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 8,575 square miles in Oregon. The following counties lie partially or wholly within these basins: Benton, Clackamas, Columbia, Douglas, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill.

Steelhead (*O. mykiss*)

Lower Columbia River ESU

Critical habitat is proposed to include all river reaches and estuarine areas accessible to listed steelhead in Columbia River tributaries between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers, Oregon (inclusive). Also included are river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to the Hood River in Oregon. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 5,017 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Clackamas, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Klickitat, Lewis, and Skamania.

Upper Willamette River ESU

Critical habitat is proposed to include all river reaches accessible to listed steelhead in the Willamette River and its tributaries above Willamette Falls. Also included are river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to and including the Willamette River in Oregon. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 4,872 square miles in Oregon. The following counties lie partially or wholly within these basins: Benton, Clackamas, Columbia, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill.

Species Proposed for Listing

Sea-Run Cutthroat Trout (*O. clarki clarki*)

Southwestern Washington/Columbia River ESU

The ESU includes populations of coastal cutthroat trout in the Columbia River and its tributaries downstream from the Klickitat River in Washington and Fifteenmile Creek in Oregon (inclusive) and the Willamette River and its tributaries downstream from Willamette Falls. The ESU also includes coastal cutthroat trout populations in Washington coastal drainages from the Columbia River to Grays Harbor (inclusive). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 12,136 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Grays Harbor, Jefferson, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston, Wahkiakum, and Yakima.

Candidate Species for Listing

Coho Salmon (*O. kisutch*)

Lower Columbia River/Southwest Washington ESU

The ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 10,418 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Grays Harbor, Jefferson, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston, and Wahkiakum.

Steelhead (*O. mykiss*)

Oregon Coast ESU

The ESU includes steelhead from Oregon coastal rivers between the Columbia River and Cape Blanco. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 10,604 square miles in Oregon.

The following counties lie partially or wholly within these basins: Benton, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Polk, Tillamook, Washington, and Yamhill.